



Endoscopic Gastrojejunal Revisions Following Gastric Bypass: Lessons Learned in More Than 100 Consecutive Patients

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Received: 4 June 2018 / Accepted: 31 August 2018 / Published online: 13 September 2018
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Abstract

Background Weight regain and dumping after Roux-en-Y gastric bypass (RYGB) are long-term challenges thought to be due to dilation of the gastrojejunal anastomosis. The aim of this study was to analyze the feasibility, safety, and outcomes of endoscopic gastrojejunal revisions (EGRs) after its introduction in a tertiary bariatric surgery center.

Methods From January 2016 to March 2018, we reviewed the electronic records of all patients undergoing EGR with the OverStitch suturing device. Demographics, procedure details, and outcomes were recorded.

Results There were 107 patients (M:F = 29:78) treated with 133 EGR procedures for weight regain ($n = 81$), dumping syndrome ($n = 13$), or both ($n = 13$) with mean age 47.3 years ($R\ 22.0$ – 72.9) and mean BMI 32.9 kg/m^2 ($R\ 22.2$ – 49.8) at time of procedure. Mean procedure time was 17.8 min ($R\ 12$ – 41), with median 1 suture used ($R\ 1$ – 2). No intra-operative or 30-day complications were recorded. Mean follow-up time was 9.2 months ($R\ 1$ – 26.8). Patients lost a mean of 4.1, 5.8, and 8.0 kg at 3, 6, and 12 months, respectively, after the procedure. Weight loss outcomes were significantly better when two compared to one suture was used ($p = 0.036$), and for patients with higher starting BMI ($p = 0.047$). For patients with dumping syndrome, 90–100% had treatment response after one or two EGRs.

Conclusion EGR is feasible and safe for weight regain and dumping syndrome after RYGB. It can stabilize weight regain and improve dumping symptoms. Around 20% of patients will need repeat EGR within 1 year to achieve sufficient narrowing of the anastomosis.

Keywords Endoscopy · Dumping · Weight regain · Gastric bypass

Introduction

Morbid obesity is a chronic condition that affects millions of people worldwide and is associated with serious comorbidities including diabetes, hypertension, hyperlipidemia, obstructive sleep apnea, osteoarthritis, and non-alcoholic fatty liver disease and has a major impact on psychological health as well as quality of life.¹ Despite advancements in understanding the metabolic, physiologic, and environmental factors that

contribute to obesity, surgery remains the only treatment that has been shown to be effective in the long term.²

Roux-en-Y gastric bypass (RYGB) is the most commonly performed surgical procedure worldwide for the long-term treatment of morbid obesity over the last 20 years. It is reported that up to 25% of patients will present with late complications such as ulcerations, strictures, weight regain, and severe dumping syndrome.^{3,4} While most of the weight loss is achieved over the first 12–18 months after surgery, weight regain is less defined, less predictable and most likely multifactorial.

Weight regain is one of the long-term challenges after RYGB in morbidly obese patients. Dilation of the gastrojejunal (GJ) anastomosis is one factor for loss of restriction and therefore weight regain; it is also a possible cause of dumping syndrome.^{5,6} It has been reported that revisional bariatric procedures nearly double perioperative morbidity to a rate of 15% compared to 8% in primary bariatric surgeries, and are associated with increased mortality rates of 0.7% compared to 0.3% in primary bariatric surgeries.⁷

This paper was presented as an Oral Presentation in the Plenary Session at Digestive Disease Week (DDW) 2018 in Washington D.C., USA, on June 5, 2018.

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Endoscopic interventions have the advantage of avoiding harsh intra-abdominal conditions present in many bariatric patients. Several novel endoscopic approaches have been described in the treatment of primary bariatric patients as well as post-bariatric surgery complications.^{3,8,9}

The aim of the study was to analyze the feasibility, safety, outcome, and learning curve of endoscopic gastrojejunal revisions (EGRs) after its introduction in a large tertiary bariatric center.

Materials and Methods

Patient Selection

We performed a retrospective chart review of all patients undergoing EGR after gastric bypass with the OverStitch suturing device (Apollo Endosurgery, Austin, TX, USA) at a single bariatric surgery center in Berne, Switzerland. Indications for EGR were weight regain, dumping syndrome, or both. From January 2016 to March 2018, we reviewed patients' electronic medical records for demographic details, procedure details, and outcome variables. Demographic data recorded included age at time of procedure, gender, and BMI. Patient comorbidities, medications, and prior surgical history were recorded. The study was approved by the local ethics review board.

Weight regain was defined as more than 15-kg increase from a patient's nadir weight, or 10-kg increase within a 6–12 months' time period. Dumping syndrome included early and late dumping with symptoms of nausea, vomiting, abdominal pain, cramping, diarrhea, sweating, weakness, dizziness, and palpitations, despite dietary modifications and counseling. All patients received pre-operative swallow study or endoscopy to confirm a dilated GJ anastomosis.

Endoscopic Technique

Informed consent was obtained in clinic before the procedure. All procedures were performed by the same team (surgeon J.Z. and gastroenterologist H.M.) at the same bariatric surgery center. All procedures were performed under general anesthesia. An upper endoscopy was performed using a standard flexible gastroscope. The esophagus, pouch, and proximal jejunum were visualized. The GJ anastomosis was measured by visual estimation. After insertion of an overtube to protect the larynx, pharynx, and proximal esophagus, the GJ anastomosis was primed circumferentially with argon plasma coagulation. The OverStitch suturing device was then introduced and narrowing of the GJ anastomosis was performed using one to two sutures, each with four to six stitches. The sutures were placed across the GJ anastomosis starting on one side of the anastomosis in a formation (clock) 2 to 4 and 1 to 5. If a second suture was used, the same pattern was applied for

further narrowing the anastomosis. A final inspection of the patency of the anastomosis was performed prior to removal of the overtube (Fig. 1). Size of the GJ anastomosis, size of the pouch, duration of operation, number of sutures, and complications were recorded. Patients were observed overnight in the hospital post-operatively per hospital policy.

Post-operative management included counseling by a dietician regarding the recommended 2 weeks of liquid diet, proton pump inhibitors (PPI) 40 mg twice a day per oral for at least 4 weeks, and pain medication as necessary.

Follow-up Schedule

The patients had routine follow-up appointments at a comprehensive care bariatric surgery center at 4 weeks, 8–12 weeks, 6 months, and 1 year after the procedure, with more frequent consultations as indicated by patient symptoms. Patients received routine dietary counseling and routine consultations from physicians specialized in the care of obese patients. Patients' weight and vitals were taken using the same equipment. Any post-operative imaging or procedures were recorded.

Outcome Measures

Primary outcome measure for technical feasibility was the intra-operative ability to narrow the GJ anastomosis. Primary outcomes for success of the EGR include BMI loss and weight loss (in kg) during the follow-up period, as well as symptom resolution for patients being treated for dumping. Primary safety outcomes include short- and long-term complications after EGR. Outcomes of a learning curve were assessed by comparison of all patients receiving EGR in 2016 to patients receiving EGR in 2017. Secondary outcome measures included procedure details, variables associated with better weight loss, and need for repeat laparoscopic surgical interventions.

Statistical Analysis

Technical success, long-term success, and complication rates were calculated. Categorical data were analyzed using chi-square tests. Using Prism 7 software, continuous data were analyzed using the Mann-Whitney *t* test and grouped variables were analyzed using ANOVA.

Results

There were 107 patients treated with EGR for either weight regain ($n = 81$), dumping syndrome ($n = 13$), or both dumping syndrome and weight regain ($n = 13$) with a total of 133 EGRs performed. Demographic details are summarized in Table 1.

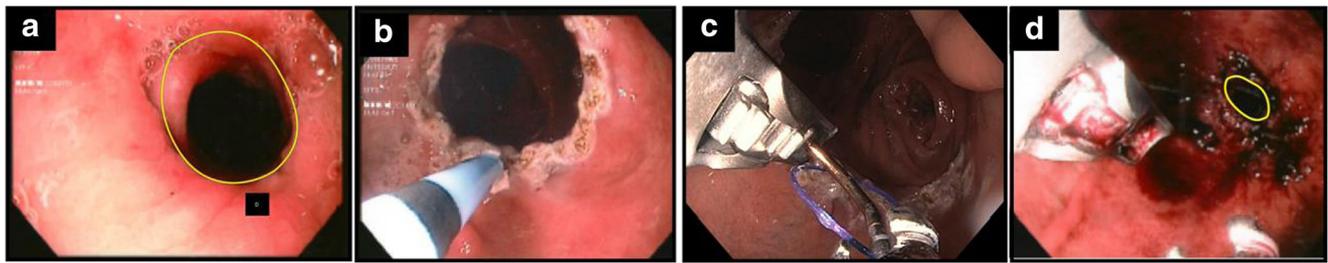


Fig. 1 Endoscopic suturing technique with the Apollo OverStitch suturing device. **a** Dilated gastrojejunal anastomosis. **b** Priming the anastomosis with argon laser coagulation. **c** Narrowing of the gastrojejunal anastomosis with the Apollo OverStitch suturing device. **d** Narrowed gastrojejunal anastomosis

There were 78 (72.9%) female and 29 (27.1%) male patients with a mean age of 47.3 years (R 22.0–72.9) and mean BMI of 44.6 kg/m² (R 35–67). The patients had a median of 3 prior abdominal surgeries (R 1–12) and received initial EGR a mean of 6.7 years (R 0.8–18.5) after RYGB. Mean follow-up time was 8.3 months (R 1–26.8).

Surgical details are summarized in Table 2. The mean initial procedure time was 17.8 min (R 12–41), with a median number of 1 suture (R 1–2) used to narrow the anastomosis. Median starting diameter of the GJ anastomosis was 22 mm (R 13–40) and median diameter at the end of the procedure was 6 mm (R 4–14). Anastomotic narrowing was achieved in

Table 1 Demographics

Baseline patient characteristics (N = 107)

	Indication for EGR			All patients
	Weight regain only	Dumping only	Dumping and weight regain	
Number of patients	N = 81	N = 13	N = 13	N = 107
Number of EGR procedures	97	17	19	133
Age (years)	48.0 (26.8–71.4)	42.5 (31.3–59.9)	47.7 (22.0–66.7)	47.3 (22.0–71.4)
Gender				
Male	22 (27.2%)	4 (30.8%)	3 (23.1%)	29 (27.1%)
Female	59 (72.8%)	9 (69.2%)	10 (76.9%)	78 (72.9%)
Comorbidities				
Diabetes	10 (12.3%)	2 (15.4%)	1 (7.7%)	14 (13.1%)
Hypertension	23 (28.4%)	1 (7.7%)	6 (46.2%)	37 (34.6%)
Hyperlipidemia	12 (14.8%)	1 (7.7%)	1 (7.7%)	14 (13.1%)
History of clots	4 (4.9%)	1 (7.7%)	1 (7.7%)	6 (5.6%)
Sleep apnea	7 (8.6%)	0 (0%)	0 (0%)	7 (6.5%)
Biometrics				
Initial weight (kg)	127.1 (96–225)	122.4 (61–156.7)	121.8 (92.9–153.6)	125.8 (61–225)
Initial BMI (kg/m ²)	44.7 (35.3–67)	44.8 (35–55.5)	44.0 (36.3–60)	44.6 (35–67)
Weight at nadir (kg)	76.7 (47–125)	75.1 (57.4–105.0)	75.5 (59–94.9)	76.5 (47–125)
BMI at nadir (kg/m ²)	26.9 (18.5–36.8)	25.6 (20.2–31.7)	28.6 (22.7–33.4)	26.9 (18.5–36.8)
Weight at EGR (kg)	94.9 (55.5–168)	82.6 (54.8–132)	87.9 (64.3–116.6)	92.5 (54.8–168)
BMI at EGR (kg/m ²)	33.6 (24.8–49.8)	29.7 (22.2–39.8)	31.6 (25.8–38.0)	32.9 (22.2–49.8)
EWL at EGR (%)	47 (16.6–83.5)	72.8 (53.4–119.8)	58.8 (30.6–87.4)	51.4 (16.6–119.8)
Surgical history				
Mean time from RYGB to EGR (years)	7.0 (1–18.5)	5.0 (0.8–10.6)	6.7 (2.3–11.7)	6.7 (0.8–18.5)
Median number of prior abdominal surgeries	3 (1–4)	3 (1–12)	3 (1–6)	3 (1–12)
Prior silastic band/ring placement	44 (54.3%)	5 (38.5%)	7 (53.8%)	56 (52.3%)
Prior gastric band placement	15 (18.5%)	6 (46.2%)	7 (53.8%)	28 (26.2%)
Mean follow-up time (months)	7.8 (1–26.8)	7.6 (1–21.8)	12.5 (1–21.4)	8.3 (1–26.8)

RYGB, Roux-en-Y gastric bypass; EGR, endoscopic gastrojejunal revision

Table 2 Operative details

Details of surgery				
	Weight regain only <i>N</i> = 81	Dumping only <i>N</i> = 13	Dumping and weight Regain <i>N</i> = 13	All patients <i>N</i> = 107
Median GJA diameter (mm)				
Start of procedure	22 (13–40)	22 (20–25)	22 (18–25)	22 (13–40)
End of procedure	6 (4–14)	6 (4–11)	6 (4–13)	6 (4–14)
Pouch length (cm)	3.5 (1.5–7)	3.5 (3–6)	3.5 (3–6)	3.5 (1.5–7)
Median number of interrupted sutures	1 (1–2)	1 (1–2)	1 (1–2)	1 (1–2)
Mean procedure time (min)	17.2 (12–33)	17.5 (12–41)	22.0 (12–37)	17.8 (12–41)
Intra-operative complications	0	0	0	0

GJA, gastrojejunal anastomosis

all cases (100%). There were no intra-operative complications recorded. In patients requiring a second EGR, mean procedure time was 19.3 min (*R* 12–40) for the second procedure.

Surgical follow-up details are summarized in Table 3. There were no complications recorded within 30 days post-operatively (no bleeding, no re-intervention, no infection, no dilation, no re-admission). A second EGR was necessary in 26 (24.2%) patients, and laparoscopic pouch revision was necessary in 13 (12.1%) patients. The mean time from initial EGR to a revisional procedure was 7.5 months (*R* 1.2–17.5).

Weight loss trends are summarized in Table 4. For patients undergoing EGR for weight regain only, mean weight loss was –4.5 kg, –6 kg, and –8 kg at 3 months, 6 months, and 12 months’ follow-up, respectively.

To assess the learning curve of EGR, the patients were grouped into patients with initial EGR in 2016 (*n* = 37) and in 2017 (*n* = 37). In patients undergoing EGR for weight regain, mean procedure time in 2016 was 18.9 min and 17.6 min in 2017 (*p* = 0.6). In the weight regain only group, 7 of 26

(26.9%) patients in 2016 and 3 of 25 (12%) patients in 2017 required laparoscopic pouch revision (*p* = 0.16). For patients in which 12-month pre-operative BMI as well as 6–12-month post-operative BMI was available, weight trends were graphed for 2016 (Fig. 2a) and 2017 (Fig. 2b). If 12-month pre-operative BMI was unavailable, the most recent pre-operative BMI was used. There was no difference in weight stabilization between 2016 and 2017.

Variables including age, gender, initial BMI, initial weight, number of prior surgeries, initial anastomotic diameter size, and procedure time were subgrouped into cohorts of comparable size to evaluate predictors for weight loss outcomes. Post-operative weight loss was significantly better when two compared to one suture was used (*p* = 0.036) (Fig. 3a), and if the patient had a higher starting BMI (*p* = 0.047) (Fig. 3b).

Outcomes for dumping syndrome are summarized in Table 5. Of the 26 patients undergoing EGR for dumping, 90–100% of patients had improvement or resolution of symptoms after one or two EGRs.

Table 3 Post-operative details

Post-operative details				
	Weight regain only <i>N</i> = 81	Dumping only <i>N</i> = 13	Dumping and weight regain <i>N</i> = 13	All patients <i>N</i> = 107
30-day complications				
Bleeding	0	0	0	0
Infection	0	0	0	0
Repeat surgery	0	0	0	0
Dilation	0	0	0	0
Patients requiring repeat EGR	16 (19.9%)	4 (30.8%)	5 (21.7%)	26 (24.2%)
Patients requiring lap. pouch revision	11 (13.65%)	1 (15.4%)	1 (7.7%)	13 (12.1%)
Mean months from initial EGR to revision	7.9 (1.6–17.5)	9.9 (4.7–19.1)	6.5 (1.2–16.9)	7.9 (1.2–19.1)

EGR, endoscopic gastrojejunal revision

Table 4 Weight loss trends

Kg weight loss in successful cases*			
	3 months post-op	6 months post-op	12 months post-op
All patients	-4.1 (-12.4 to 0) <i>n</i> = 62	-5.8 (-24.8 to -0.2) <i>n</i> = 36	-8.0 (-24.8 to -1.3) <i>n</i> = 29
Weight regain only	-4.5 (-12.4 to 0) <i>n</i> = 49	-6.0 (-24.8 to -0.2) <i>n</i> = 28	-8.0 (-.8 to -0.2) <i>n</i> = 24
Dumping only	-3.9 (-13.1 to 0) <i>n</i> = 3	-6.8 (-13.9 to -2.6) <i>n</i> = 4	-6.9 (-15.1 to -0.2) <i>n</i> = 3
Weight regain and dumping	-1.9 (-7.3 to 0) <i>n</i> = 10	-3.9 (-6.3 to -2.5) <i>n</i> = 4	-7.8 (-8.6 to -7.0) <i>n</i> = 2

*Successful case = either weight maintenance or weight loss

Table excludes patients who received a laparoscopic pouch revision

Discussion

In this series of more than 130 consecutive procedures performed in more than 100 patients over a 2-year time period, we show the safety and feasibility of EGR after its introduction in a large tertiary bariatric center. Further, we analyzed the outcomes of 107 patients and assessed the learning curve comparing year 1 and year 2. Our results showed successful weight loss after 6 months and 12 months if performed for weight regain. Further, adding a second suture compared to one suture and patients with higher starting BMI had improved outcomes.

Weight regain after bariatric surgery is reported to be as high as 60% within 4 years after RYGB.⁵ A dilated GJ anastomosis after RYGB is thought to be one of the factors leading to weight regain due to loss of restriction and thus reduction in satiety stimulation.⁵ A study done by Abu Dayyeh et al. showed that increasing GJ anastomotic diameter was significantly associated with weight regain after RYGB.⁵ Prior techniques to narrow a dilated GJ anastomosis include sclerotherapy, however with varying rates of success.^{10–13} Endoscopic narrowing of the GJ anastomosis using suturing systems and tissue-apposition systems is increasingly performed procedures, with many

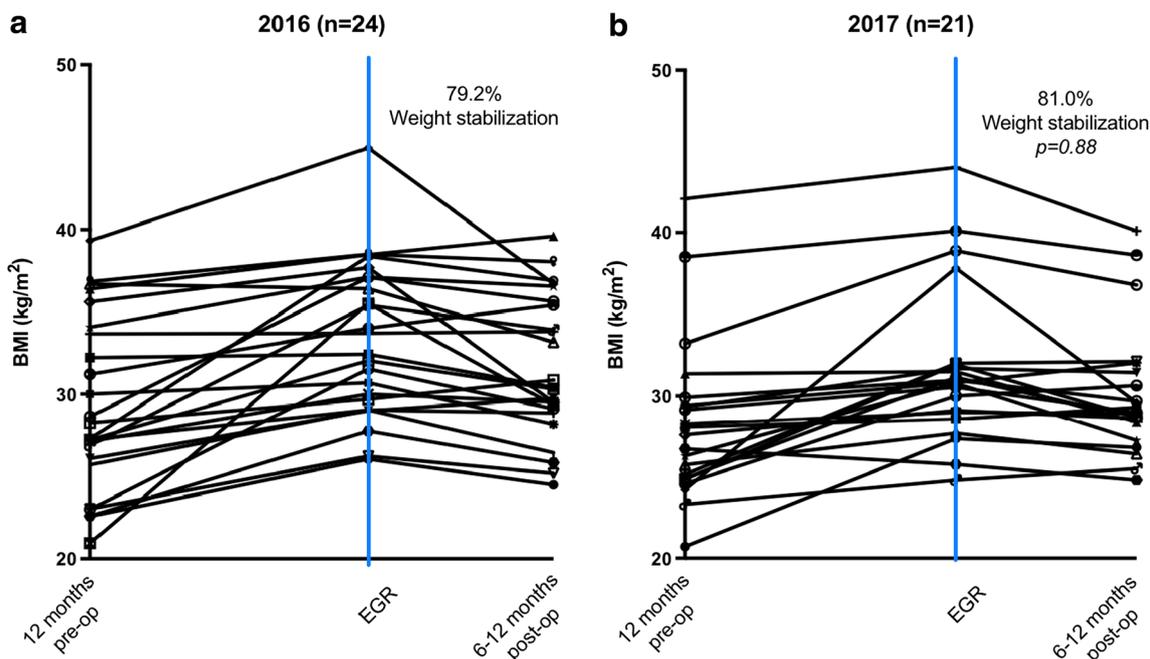


Fig. 2 Weight loss trends 2016 vs. 2017. Graphs include patients with complete pre-operative, operative, and 6–12 months' post-operative weight. **a** Weight loss trends in 2016: 79.2% of patients achieved weight stabilization in the 6–12 months' follow-up period. **b** Weight

loss trends in 2017: 81.0% of patients achieved weight stabilization in the 6–12 months' follow-up period. There was no significant difference in weight trends between 2016 and 2017 ($p=0.88$). EGR, endoscopic gastrojejunal revision

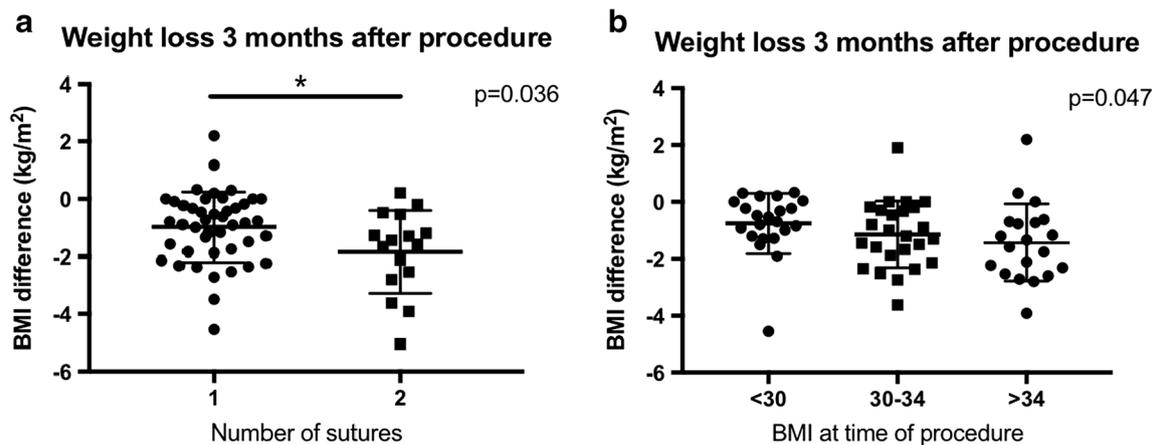


Fig. 3 Subgroup analyses for weight loss 3 months post-operatively. **a** There was a significant decrease in BMI at 3 months for patients receiving 2 sutures compared to 1 during endoscopic gastrojejunal revision ($p =$

0.036). **b** Comparing the BMI at time of endoscopic gastrojejunal revision in three groups of similar size, the decrease in BMI at 3 months was greater in patients with higher starting BMI ($p = 0.047$)

studies having promising results to support its wider adoption in clinical practice.^{8,9,14–17}

Kumar et al. compared outcomes of a superficial suturing device (EndoCinch) with the same full-thickness suturing device used in our study (Apollo OverStitch suturing device), showing better weight loss with full-thickness suturing.¹⁸ They theorize that deeper bites with the curved needle of the OverStitch allow for better approximation and a smaller effective outlet. Another system that was studied was the EndoSurgical Operating System (EOS), again studied by the group of Thompson.¹⁵ The study was done in 20 patients and technical success was 85%. Due to the configuration of the device, the procedure could not be performed in all patients. One of the largest randomized multicenter studies of EGR comparing the use of EndoCinch vs. a sham group was also published by Thompson et al.⁸ The study was done across 11 centers in the USA and included 50 patients in the treatment group who underwent GJ anastomotic revisions using the EndoCinch and 27 patients in the control group who underwent a sham procedure. Weight loss results were significantly better in the treatment group, and the control group had a trend towards weight gain post-operatively.

Early experience with the OverStitch suturing device for EGR was published in a smaller series with 25 patients by Jirapinyo et al.¹⁹ They had similar results regarding weight loss and used a mean of three interrupted stitches. They recommended avoiding a final GJ diameter of less than 4 mm, as these patients had more nausea and emesis. In another study, they published their experience with 50 procedures in 47 patients comparing the interrupted vs. purse-string suture techniques.¹⁸ In this study, 55.9% of patients in the interrupted group felt restriction at initial follow-up compared to 93.7% in the purse-string group. While the purse-string technique seemed more effective at early follow-up, breakdown of one point of the suture might more likely loosen the entire suture compared to interrupted sutures. Riva et al. studied EGR comparing use of the OverStitch suturing device alone vs. a combination of OverStitch with sclerotherapy.²⁰ There were 22 patients in this study, and after 22 months of follow-up, sclerotherapy combined with the Apollo OverStitch trended towards better outcomes than suturing alone. Another larger international multicenter study was published by Vargas et al. with 130 cases at 3 large bariatric institutions in the USA and Brazil.¹⁶ Similar to our results, the weight loss at 12 months

Table 5 Dumping post-operative symptoms

Follow-up for dumping symptoms	Dumping only (N= 13)		Dumping and weight regain (N= 13)	
	Number	Percentage	Number	Percentage
Required repeat EGR (for dumping)	4	36.4%	3	25%
Required laparoscopic pouch revision (for dumping)	1	9.1%	0	0%
1-month treatment response ⁺	9	81.1%	11	91.7%
Intermediate treatment response* ⁺	9	90%	12	100%

*After 1 or 2 EGRs within 6–12 months’ follow-up

⁺ Treatment response = resolution or improvement in dumping symptoms

Table excludes patients receiving re-intervention for weight regain

was 8.4 kg, and 8% required a repeat procedure. They advocate for performing EGR early in the management algorithm of weight regain after RYGB in patients with dilated GJ anastomoses.

There is still controversy regarding the importance of sizing the pouch and the GJ anastomosis in primary laparoscopic RYGB. Furthermore, there is discussion regarding the usefulness of adding a silastic ring around the pouch (banded gastric bypass). Surgeons performing the circular stapler technique will see more anastomotic stenosis requiring endoscopic balloon dilation than surgeons performing the linear stapler technique. Surgeons who prefer the circular stapler technique believe that the circular stapled anastomosis gives a defined diameter that will last longer without dilation. The same argument is used for placing the silastic ring; it could prevent pouch dilation as a result of overeating, therefore avoiding weight regain as well as lowering the rate of dumping syndrome. In this series, all patients had a primary or secondary RYGB. In most of the patients, a silastic ring was placed. In some patients, the silastic ring had to be removed due to solid food intolerance, slippage, or frequent vomiting. While their eating quality increased, it was often associated with weight regain.

Experienced centers with consequent follow-up will face weight regain as a challenge in patients 2–5 years after gastric bypass. In our series, the patients were followed in our dedicated outpatient center for bariatric surgery, and therefore changes in body weight are quickly noticed and addressed. The first step in our treatment algorithm to avoid, halt, or reverse weight regain at annual follow-up is dietary counseling and reminding patients of the main principles for maintaining weight loss. The second step is adding medication and/or intensive dietary counseling. Patients are considered for EGR if they gained more than 10 kg within 6 months to 1 year, gained more than 15 kg since their weight nadir, or reacquired comorbidities that had previously resolved. Indications for EGR can be more liberal as the morbidity rate of the procedure is close to 0. In our study, there were no procedure-related complications intra-operatively nor within the first 30 days. Even during the over 2-year follow-up period, no complications were seen aside from redilation of the anastomosis or suture breakdown.

While we could show that the procedure is safe and feasible, we have no long-term data to support the durability of EGR using the OverStitch suturing device. Several patients (20%) from the entire study cohort needed another EGR because of insufficient restriction to either further narrow the anastomosis or redo it in case of suture breakdown or suture migration. As we had no routine upper endoscopy results in all of the patients 6–12 months after surgery, we cannot determine the exact number of patients with either suture breakdown or redilation. Our algorithm includes one to two procedures with the endoscopic

suturing device before considering the patient for a laparoscopic pouch revision. In some patients with prior abdominal surgeries or bariatric revisions, a laparoscopic pouch revision with stapling of the pouch, plication of the pouch, revision of the anastomosis, or adding a silastic ring can be judged as too dangerous. Endoscopic revisions in such cases are a safer alternative. While primary RYGB has an acceptable low rate of leaks (1%), secondary RYGB and even more laparoscopic pouch revisions are associated with leak rates as high as 11.5%.²¹ There were no perforations seen during EGR or during follow-up. While we mostly used one suture with four to six stitches in the patients in the first year of the study, we modified our technique in the second year by adding a second suture with four to six stitches to further narrow the anastomosis based on our results showing better outcomes with a second suture. While narrowing the anastomosis with the endoscopic suturing device causes immediate mucosal hematoma, the visible narrowing can be overestimated in inexperienced hands. In small pouches, the handling of the suture device can be challenging, and therefore a second suture can be difficult or impossible. Bleeding can occur and is usually controlled in the moment the suture is cinched and the cinching device placed. In our series, it was not necessary to actively stop bleeding by clips or adrenal injections and no patients needed a blood transfusion.

The post-procedure standard in our series was 2 days of clear liquid diet followed by 2 weeks of liquid diet, PPI 40 mg twice a day per oral for at least 4 weeks, and pain medication as needed. The first reason for a clear liquid diet was to minimize the risk of aspiration, as the anastomosis could be too narrow due to swelling, hematoma, or a technically too small lumen. The second reason was to avoid food bolus impaction within the first 2 weeks, as healing of the anastomotic narrowing could be harmed by pressure and mechanical dilation with solid food. By having a dietician in the hospital who will explain the diet, goals, and reasons before discharge, higher compliance might be achieved. We had no return to the emergency room for dehydration or pain in our series. It is important to avoid nausea and especially vomiting post-operatively to prevent early suture migration or rupture. A longer duration of a liquid diet would be beneficial; however, from our prior experience, we had poor patient compliance beyond a 2-week liquid diet.

Dumping syndrome is characterized by diarrhea and abdominal pain after meals and is reported in up to 70% of post-RYGB patients.^{22,23} While in some cases dumping is desirable to achieve weight loss after RYGB, some patients develop intractable and debilitating symptoms such as lightheadedness, sweating, fatigue, palpitations, and seizures despite diet modifications. Dumping syndrome is

classified as early and late dumping; early dumping syndrome is caused by the rapid emptying of high-osmolarity food through the gastric pouch. This causes the small intestine to bring fluid into the intestinal lumen, especially after a high-glucose meal.²⁴ Late dumping syndrome is caused by rapid absorption of carbohydrates in the proximal small bowel, causing a rapid rise in blood sugar levels leading to insulin over-excretion from the pancreas resulting in hyperinsulinemic hypoglycemia.²⁵ It has been theorized that narrowing of the GJ anastomosis could help to delay the rapid emptying of food and lead to symptomatic improvement.⁶ The benefit of EGR using the OverStitch in patients with dumping syndrome was previously published by Stier et al.²⁶ In their series of 14 patients, they had 93% success after 1-month follow-up, which compares to the 90–100% in our study. Similar results were published by Fernández-Esparrach in a small series of 6 patients using EndoCinch for EGR in patients with dumping syndrome.⁶

While our study includes a large number of patients and procedures, there are several limitations that must be addressed. First, the follow-up time period is short and there is no data available regarding durability of the procedure after 2 or more years. Second, this is a retrospective study without randomization of patients to EGR or either conservative treatment or a sham procedure. Third, this is a single-institution study with selection bias and confounding by indication.

We could show a learning curve, which might be explained by the more liberal addition of a second suture in the second year of the study. Results in the first year were as good as those in the second regarding weight stabilization, procedure time, and rate of subsequent laparoscopic procedures. The learning curve did not have an impact on safety and feasibility, and only a minor impact on the outcome results. The conclusion is therefore that EGR can be easily introduced in the multidisciplinary treatment concept of a bariatric surgery center, if either an experienced endoscopic surgeon or gastroenterologist is available and already performing advanced endoscopic procedures.

Conclusion

Endoscopic gastrojejunal revision is a feasible and safe procedure for weight regain and dumping syndrome after RYGB. It can successfully stop the progression slope of weight regain or achieve additional weight loss. Better outcomes are associated with two compared to one suture during EGR, and for patients with higher starting BMI. EGR can be immediately adopted at a new institution. Around 20% of patients will need repeat endoscopic intervention within 1 year to achieve sufficient narrowing of the anastomosis.

Author Contribution Catherine Tsai participated in acquisition, analysis, and interpretation of data. Rudolf Steffen participated in interpretation of the data. Ulf Kessler and Hans Merki participated in design of the work. Joerg Zehetner participated in design of the work, analysis, and interpretation of data. All authors participated in drafting the work or revising it critically for important intellectual content, participated in final approval of the version to be published, and agree to be accountable for all aspects of the work.

Compliance with Ethical Standards

The study was approved by the local ethics review board.

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

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