Laparoscopic minigastric bypass as a revisional choice for failed restrictive bariatric procedure and its metabolic impact

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Background
Restrictive bariatric procedures, like laparoscopic adjustable gastric banding (LAGB) and laparoscopic sleeve gastrectomy (LSG), are associated with an increased risk of long-term failure. The efficacy of One-anastomosis gastric bypass (OAGB) has been described in primary and revisional settings, with a lack of Egyptian studies regarding OAGB as a revisional surgery. Herein, we describe our experience regarding 1-year outcomes of OAGB as a revisional surgery after failed LSG or LAGB.
Patients and methods
Fifty patients with failed LSG or LAGB were enrolled in this prospective study. All cases underwent laparoscopic OAGB, and its effects on weight loss and obesity-related comorbidities were noticed after 3, 6, and 12 months.
Results
The duration of the operation ranged between 45 and 120 min Postoperative complications included leakage (2%), hemorrhage (2%), and port site infection (2%). OAGB as a revisional surgery led to a significant and effective weight loss, as the percent of excess weight loss (%EWL) had mean values of 23.72%, 51.54%, and 80.25% at the scheduled visits, respectively. The procedure was associated with a significant rise in hemoglobin and albumin, significant decline in blood sugar, glycosylated hemoglobin, vitamin B12, and most lipid profile parameters, with no significant changes in serum calcium and high-density lipoproteins. Beneficial effects (remission or improvement) were noticed in 88.9% of diabetic cases, 80% of hypertensive cases, and 100% of reflux cases at one-year follow-up visit.
Conclusion
Laparoscopic OAGB as a revisional surgery is a safe and efficacious procedure in the management of patients with failed previous restrictive procedures like LSG and LAGB.

Keywords:
minigastric bypass, restrictive bariatric procedures, revisional

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Introduction

Obesity has become a crucial public health problem for the Egyptian government, as this problem affects about one third of the adult Egyptian population (39.8%) [1]. Bariatric procedures have been proven to be a safe and effective management option for that problem, as the obese individual could lose about 40% of his excess weight during the first year after the procedures. These procedures are better options for maintaining weight loss with a beneficial impact on obesity-associated comorbidities, than the nonsurgical options (dietary and pharmacological therapies) [2,3].

Laparoscopic adjustable gastric banding (LAGB) was one of the most common bariatric procedures in the early decade of the 21st century, whereas it ranked fourth in the subsequent decade [4]. Nowadays, laparoscopic sleeve gastrectomy (LSG) is one of the most commonly performed bariatric procedures [5]. Both of the previous two procedures were described as effective in achieving the general goals of any bariatric procedure (weight loss and comorbidity improvement) [6,7]. However, the previous procedures are restrictive in nature, making them associated with an increased risk of long-term weight regain, mechanical complications, and impaired eating habits [8,9]. Weight regain has been reported in up to 9.8% and 26% of cases after LSG and LAGB, respectively [10].

The minigastric bypass (MBG) procedure was introduced to the bariatric community in 2001 by Rutledge [11]. That procedure is as effective as the Roux-en-Y procedure [12,13], along with other advantages, including an easier learning curve, a shorter operative time, and a lower risk of major complications [14,15]. Since its description, it has been practiced widely in both primary and revisional settings [16–18].

As the surgical management of obesity rises in Egypt, it is expected to encounter post-bariatric patients reporting weight regain or complications. Data regarding OAGB as a revisional surgery in the Egyptian setting is lacking, which was a good motive for us to conduct the current study, which aimed to evaluate the efficacy of OAGB as a revisional surgery and its metabolic impact after failed LSG and LAGB procedures.

Patients and methods

We enrolled 50 patients in this prospective interventional study that was conducted at the General Surgery Department of Al-Azhar University Hospitals, Assiut, Egypt, after gaining ethical approval from the Institutional Review Board (IRB) of our medical school. The study was designed for adult patients whose body mass index (BMI) was >30 kg/m^2, who underwent previous LSG or LAGB and presented with weight regain, inadequate weight loss, failure of improvement of obesity-associated comorbidities, or complications related to the primary procedure (e.g., refractory reflux in patients with previous LSG). Inadequate weight loss was defined as the inability to achieve >50% excess weight loss (% EWL) 1.5 years after the primary procedure [19], while weight regain was defined as a progressive gain of weight after achieving >50% EWL [20].

Contrarily, we excluded patients whose BMI was <30 kg/m2 or who had uncontrolled systemic comorbidities (uncontrolled hypertension, renal, cardiac, or hepatic insufficiency), a previous history of alcohol or substance abuse, a major psychiatric illness, coagulation disorders, or an inability to tolerate laparoscopy and general anesthesia.

Patient evaluation included routine history taking (focusing on the type of the primary procedure, timing, and rationale for seeking revisional surgery), clinical assessment, and preoperative laboratory investigations (hemoglobin, albumin, random blood glucose, serum calcium, serum vitamin B12, and lipid profile). Beside pelviabdominal ultrasonography, a barium meal was ordered for all cases for objective delineation of the upper GI anatomy. The operative data of the primary procedure were also reviewed. All patients were recommended to follow a high-protein and low-carbohydrate diet two weeks before surgery, while antithrombosis prophylaxis was done the night before surgery (leg stockings and low molecular weight heparin).

All revisional procedures were performed by laparoscopy under general anesthesia, while the patient was in French position. Abdominal insufflation was done via the Veress needle, which was inserted through the umbilicus, or the Palmer point, according to surgeon preference. The procedure was performed via the five-port approach (periumbilical port for the camera, two working ports at the right and left midclavicular lines, and two assistant ports, one at the left anterior axillary line and the second at the epigastrium). The detected abdominal adhesions were carefully dissected using the ligasure sealing device, until a clear identification of the stomach and left liver lobe was possible. The stomach was freed from the undersurface of the left liver lobe using laparoscopic scissors and the ligasure device. In patients with previous LAGB, it was divided and then removed through the 10-cm working port. In cases with previous LSG, the greater gastric curve was dissected from the adhesive greater omentum to clearly identify the previous staple line.

In all cases, dissection was done to the left of the gastroesophageal junction, till creating a hole in that area. This allowed access to the posterior wall of the stomach, which facilitated the later creation of the gastric pouch. We then moved towards the lesser curvature and identified a point at the 'crow's foot' level as close as possible to the gastric serosa, and we started to make a hole through the lesser omentum in order to gain access to the lesser sac.

A 45 mm green or black endo-stapler cartridge (Ethicon, USA) was introduced and used to transect the stomach horizontally. After that, a 40-Fr bougie was inserted over the lesser gastric curve until reaching the line of gastric transsection. We continued the vertical stomach transection until reaching the gastroesophageal junction. We used two or three 60-mm gold or blue endo-stapler (Ethicon, USA) cartridge to complete the transaction of the stomach. In some cases with previous LSG, where the stomach was completely transected from the lower gastric remnant, the excluded part was removed from the abdominal cavity through the working port. Any significant bleeding points over the gastric pouch or the remaining excluded stomach were controlled by clips.

Using the diathermy, a hole was created at the created gastric pouch just posterior to the staple line, and that the hole was used to create the anastomosis between the gastric pouch and the small bowel about two meters from the Treitz ligament. The anastomosis was done via a blue cartridge, and the remaining defect was closed with continuous PDS 2/0 sutures.

An intraoperative methylene blue test was done to ensure the integrity of the anastomosis and the newly created gastric pouch. After a good wash and hemostasis, a drain was inserted along the staple line of the gastric pouch, and reaching down to the anastomosis. Abdominal deflation was done, and the skin of the created ports was closed using prolene 3/0 sutures. After the procedure ended, all patients were transferred to the internal ward with close monitoring. Oral fluid intake was usually allowed on the first postoperative day after an oral gastrograffin test. Discharge was often allowed on the 2nd or 3rd postoperative day after ensuring adequate oral intake and the absence of early postoperative complications. Any complications were recorded and managed. Postdischarge dietary, macronutrient, and micronutrient intake was according to the published guidelines [21,22].

After the removal of stitches, follow-up visits were arranged for all patients 3, 6, and 12 months after the operation. The degree of weight loss was expressed as the %EWL [23], and it was recorded at these visits. Additionally, the same preoperative laboratory parameters were repeated during these visits. Improvement, resolution, or worsening of obesity-related comorbidities, including diabetes, hypertension, and reflux, were defined according to Brethauer and his colleagues [24].

Our primary outcome was the %EWL and changes in obesity-associated comorbidities, whereas secondary outcomes included operative time, duration of hospitalization, and postoperative complications.

The previously data were collected, tabulated, and analyzed using the SPSS software for macOS (version 26). Categorical data were expressed as numbers and percentages, and compared between two-time points via McNamar's test. Numerical data were expressed as mean (with standard deviation) or median (with range) according to the mode of distribution. These data were compared between three or more time points via the repeated measures ANOVA test. Each individual two time points were also compared, and p1, p2, and p3 were used to describe the comparison of the recorded reading to its corresponding preoperative, 3-month, and 6-month values, respectively. Any P value less than 0.05 was considered significant in the statistical analysis.

Results

The mean age of the included cases was 40.66 years (range 21–58). Most of the included cases were women, as they constituted 68% of the study population, while the remaining cases were men. The preoperative BMI of the included cases was 42.94 kg/m2 (range 35–52).

Regarding the primary bariatric procedure, 36 patients underwent LSG (72%), while the remaining patients underwent LAGB (28%). The duration since the primary procedure ranged between 2 and 12 years (mean=5.56 years).

Regarding the indication of conversion, 44% of patients reported persistent obesity-related comorbidities, 48% of them had inadequate weight loss, 22% of them had weight regain after initial weight loss, and only 4% of cases had complications related to the primary procedure that required conversion.

Regarding the existing comorbidities related to obesity, diabetes mellitus was present in 9 cases (18%), whereas hypertension was present in 5 cases (10%). In addition, reflux symptoms were reported by 12 cases (24%) (Table 1).

The duration of the operation ranged between 45 and 120 min (mean=87.5 min). All cases were performed using a 40-Fr bougie and a two-meter afferent limb. The duration of hospitalization ranged between two and three days, while oral fluid intake was allowed on the first POD (range, 0–1). Leakage was encountered only in one case (2%), and it was managed by endoscopic stenting. Bleeding was encountered in only one case (2%) and it was managed by blood transfusion. Only one case developed a port site infection (2%), and it was managed by frequent dressing and antibiotics (Table 2).

As shown in Table 3, the OAGB as a revisional surgery was associated with a significant decrease in BMI at the scheduled follow-up visits ($P<0.001$). It decreased from 42.94 kg/m2 before the operation down to 38.76, 33.69, and 28.38 kg/m2 at three-, six-, and twelve-month follow-up, visits respectively. The % EWL had mean values of 23.72%, 51.54%, and 80.25% at the scheduled follow-up visits, respectively.

Although albumin level showed a statistically significant decrease at the 3-month follow-up visit compared to baseline ($P<0.001$), that difference was clinically irrelevant (from 3.82 gm/dl at baseline to 3.52 gm/dl at the three-month visit). The following two readings showed no significant difference from the baseline (3.81 and 3.84 gm/dl, respectively).

The revisional procedure was associated with a significant rise in hemoglobin level, while random blood sugar, HbA1C, vitamin B12, and most lipid profile parameters significantly decreased. Both serum calcium and high-density lipoproteins did not show any significant changes after the procedure. Table 4 summarizes the previous data.

As regards changes in obesity-associated comorbidities, the included 9 patients diagnosed with diabetes showed partial remission in 66.7% of them after 6 months. The next visit showed that complete remission was achieved in 22.2% of cases, while partial remission was present in 11.1% of cases. Improvement was present in 55.6% of cases, whereas only one patient remained unchanged (11.1%) (Table 5).

From the five patients diagnosed with hypertension, one showed improvement (20%) while another showed partial remission (20%) at the 6-month follow-up visit. At the subsequent visit, two patients showed improvement (40%), one patient showed complete remission (20%), one patient showed partial remission (20%), and one patient showed no changes (Table 6).

Regarding the 12 patients with reflux, the six-month follow-up visit showed complete remission in one patient (8.3%), while seven cases showed improvement (58.3%). At the subsequent visit, complete remission was detected in 9 cases (75%), while the remaining cases showed improvement (25%) (Table 7).

Table 1 Demographic data, medical, and surgical history of the study participants

Items	Study cases N=50
Age (years)	
Mean±SD	40.66±9.01
Median (min-max)	40.5 (21–58)
Sex	
Male	16 (32%)
Female	34 (68%)
BMI (Kg/m^2)	
Mean±SD	42.94±4.45
Median (min-max)	42 (35–52)
Primary bariatric procedure	
LSG	36 (72%)
LAGB	14 (28%)
Duration since the primary procedure	
Mean±SD	5.56±2.68
Median (min-max)	5 (2–12)
Indication for conversion	
Persistent comorbidities	22 (44%)
Complications	2 (4%)
Inadequate weight loss	24 (48%)
Weight regain	22 (44%)
Comorbidities	
Diabetes	9 (18%)
Hypertension	5 (10%)
Reflux	12 (24%)

Table 2 Operative data of the OAGB as a revisional surgery procedure

Items	Study cases N=50
Operative time (Min)	
Mean±SD	87.5±14.18
Median (min-max)	86 (45–120)
Hospital stay (Days)	
Mean±SD	2.18±0.39
Median (min-max)	2 (2–3)
Start of oral intake (Days)	
Mean±SD	6.44±4.68
Median (min-max)	6 (4–24)
Complications	
Leakage	1 (2%)
Bleeding	1 (2%)
Port site infection	1 (2%)
Stomal stenosis	0 (0%)
Vomiting	0 (0%)

Table 3 BMI and %EWL changes after OAGB as a revisional surgery

	Preoperative (n=50)	Three months (n=50)	Six months (n=50)	Twelve months (n=50)	Test of significance
BMI (kg/m2)	42.94±4.45	38.76±3.91	33.69±3.83	28.38±2.35	F=44.273 $P<0.001$
P_1		<0.001**	<0.001**	<0.001**	
P_2			<0.001**	<0.001**	
P_3				<0.001**	
%EWL	–	23.72±7.05	51.54±14.09	80.25±10.53	F=157.69 $P<0.001$
P_2	–		<0.001**	<0.001**	
P_3	–			<0.001**	

Table 4 Changes in the laboratory parameters after the OAGB as a revisional surgery procedure

	Preoperative (n=50)	Three months (n=50)	Six months (n=50)	Twelve months (n=50)	Test of significance
Haemoglobin	13.66±1.26	13.47±1.12	14.81±1.33	14.57±1.19	F=14.689 P<0.001
P_1		0.353	<0.001**	<0.001**	
P_2			<0.001**	<0.001**	
P_3				0.331	
Albumin	3.82±0.39	3.52±0.34	3.81±0.36	3.84±0.39	F=9.548 P=0.001
P_1		<0.001**	0.938	0.159	
P_2			<0.001**	<0.001**	
P_3				0.728	
Random blood sugar	107.88±31.72	110.74±24.29	110.32±20.87	97.64±18.02	F=10.640 P<0.001
P_1		0.428	0.493	0.024*	
P_2			0.877	<0.001**	
P_3				<0.001**	
Calcium	8.90±0.88	8.91±0.73	8.83±0.65	8.83±1.09	F=0.849 P=0.620
P_1		0.966	0.544	0.706	
P_2			0.538	0.692	
P_3				0.979	
HbA1C	5.95±1.02	5.68±0.88	5.08±0.55	4.62±0.69	F=23.184 P<0.001
P_1		0.196	0.013*	<0.001**	
P_2			0.038*	<0.001**	
P_3				0.046*	
Vitamin B12	412 (147-3336)	323 (120-753)	189 (123-366)	144 (78-189)	Fr=148.640 P<0.001
P_1		<0.001**	<0.001**	<0.001**	
P_2			<0.001**	<0.001**	
P_3				<0.001**	
Low-density lipoproteins	88 (23-321)	77 (29 –305)	78 (34–190)	65 (32–102)	Fr=69.484 P<0.001
P_1		0.043*	0.013*	<0.001**	
P_2			<0.001**	<0.001**	
P_3				<0.001**	
High-density lipoproteins	50 (20–110)	49 (32–90)	48 (28–90)	54 (20–78)	Fr=1.426 P=0.387
P_1		0.347	0.278	0.194	
P_2			0.804	0.238	
P_3				0.530	
Triglycerides	60 (33–170)	90 (40–190)	70 (33-180)	60 (30–170)	Fr=6.489 P=0.002
P_1		0.002*	0.195	0.921	
P_2			0.060	<0.001**	
P_3				<0.001**	
Cholesterol	60 (33–170)	90 (40–190)	70 (33-180)	60 (30–170)	Fr=9.206 P=0.001
P_1		0.313	0.534	<0.001**	
P_2			0.036*	<0.001**	
P_3				<0.001**	

Discussion

The OAGB as a revisional surgery has been described in previous studies, as the need for revisional procedures is globally increasing (from 6% to 13.6% of all bariatric procedures) [10]. Yet, it is poorly described in the Egyptian setting, especially given that OAGB is the main revisional procedure performed for failed restrictive procedures in Egypt. That poses an advantage in favor of our trial.

In our study, the indications for conversion were inadequate weight loss (48%), weight regain (44%), persistent comorbidities (44%), and primary procedure-related complications (4%). Ghosh and his associates reported that their indications were as follows; inadequate weight loss or weight regain (48.65%), intolerance (24.32%), weight increase after removal of the band (10.81%), prothesis-related issues (6.76%), dilatation of the gastric pouch (5.4%), band erosion (2.7%), and band slippage (1.35%) [25]. Another study reported different indications as follows; inadequate weight loss (66%), reflux symptoms (13%), gastric tube prolapse (10%), and dysphagia (10%) [26]. It is expected to find some

Table 5 Effect of the revisional procedure on diabetes mellitus

Items	Diabetes cases *N*=9
At 3 months	**Number (Percent)**
Unchanged	3 (33.3)
Partial remission	5 (55.6)
Improved	1 (11.1)
At 6 months	
Unchanged	3 (33.3)
Partial remission	6 (66.7)
At 12 months	
Unchanged	1 (11.1)
Partial remission	1 (11.1)
Complete remission	2 (22.2)
Improved	5 (55.6)

Table 6 Effect of the revisional procedure on hypertension

Items	Hypertension cases *N*=5
At 3 months	**Number (Percent)**
Unchanged	5 (100)
At 6 months	
Unchanged	3 (60)
Partial remission	1 (20)
Improved	1 (20)
At 12 months	
Unchanged	1 (20)
Partial remission	1 (20)
Complete remission	1 (20)
Improved	2 (40)

differences in the indications for revision in the existing studies, and those would differ based on the sample size included, the primary procedure, the duration since the primary procedure, and the severity of comorbidities.

In the current study, the duration of the operation ranged between 45 and 120 min (mean =87.5 min). This lies within the reported range in the current literature. Chiappetta *et al.* reported a mean operative time of 78.7 min (range, 25–183) [27]. In contrast to the previous findings, other authors reported a longer operative duration (about 95 min) [28,29]. Differences between studies could be due to different primary procedures, complication types, surgeon experiences, and healthcare facilities.

In our study, leakage was encountered in only one case (2%), and it was managed by endoscopic stenting. This is in accordance with previous studies that reported a leakage rate between 1.35% and 2.04% after OAGB as a revisional surgery [25,30]. However, some authors believe that revisional procedures carry an increased risk for postoperative leakage compared to the primary ones (a nine-fold increase) [31].

Table 7 Effect of the revisional procedure on reflux

Items	Reflux cases *N*=12
At 3 months	**Number (Percent)**
Unchanged	4 (33.3)
Complete remission	1 (8.3)
Improved	7 (58.3)
At 6 months	
Unchanged	4 (33.3)
Complete remission	1 (8.3)
Improved	7 (58.3)
At 12 months	
Complete remission	9 (75)
Improved	3 (25)

Our findings showed the incidence of postoperative hemorrhage in one patient (2%) who was managed by blood transfusion. Previous studies reported an incidence between 0.5% and 1.4% for the same complication following OAGB as a revisional surgery [32,33], which is near our findings.

In our study, only one patient developed a port site infection after the OAGB as a revisional surgery (2%), and that lies within the previously reported range of the same complication following revisional bariatric procedures (range between 1.35% and 2.7%) [25,32].

No cases experienced postoperative vomiting in the current study. That could be explained by the good tolerance to oral intake following OAGB as the anastomosis prevents the formation of a high-pressure zone inside the newly created gastric pouch.

In our study, the duration of hospitalization ranged between two and three days. Another study reported that the average hospital stay was 3.1 days (range, 3–8) [33]. Additionally, Debs *et al.* reported similar findings [34]. Both of the previous two studies reported durations near ours. Others reported longer durations. Chiappetta *et al.* reported a 5-day hospitalization period in all selected patients [27]. Differences could be explained by different center protocols and complication rates.

Our findings showed that OAGB as a revisional surgery achieved %EWLs of 23.72%, 51.54%, and 80.25% at 3, 6, and 12 month follow-up visits, respectively. This indicates its efficacy as a bariatric procedure in achieving adequate weight loss. Previous two studies assessed %EWL outcomes at the same intervals. Ghosh *et al.* reported that %EWL had mean values of 37.8%, 55.1%, and 67%, respectively [25], whereas Noun *et al.* reported mean values of 41.7%, 73.7%, and 81.6% at the same time intervals, respectively [28].

The mechanism of weight loss after OAGB is multifactorial and includes decreased calorie intake, increased secretion of satiety hormones, bile acid changes, and alternations in the intestinal microbiota [35]. That's what makes OAGB more effective than purely restrictive procedures that mainly depend on decreased food intake. Differences in weight loss between different studies could be explained by differences in preoperative BMI, surgical technique (biliopancreatic limb length or stoma size), postoperative dietary regimen, or postoperative exercise plan.

In the current study, hemoglobin levels showed a significant rise at the six-and twelve-month follow-up visits compared to the baseline value. Although most of these changes are subtle and considered irrelevant in clinical practice, they indicate proper nutritional supplementation in our cases. On the other hand, another study reported that OAGB was associated with a significant decline in the same parameter (P=0.006). It decreased from 12.07 before the operation down to 11.7 mg/dl after it. Although the difference was statistically significant, it was insignificant from the clinical point of view [30]. The same findings were also noticed in the study of Zamaninour and his associates [36].

In our study, the last two albumin readings showed no significant difference from the baseline one. This could be explained by high protein diet recommended for our patients along with the commenced protein supplementations. Zamaninour *et al.* reported that OAGB led to a significant decline in albumin levels (P<0.001), from 4.33 to 4.18 mg/dl. However, that decline did not have a significant impact on patient status, and was within the normal albumin range [36]. Another study reported that OAGB as a revisional surgery was not associated with significant changes in serum albumin levels (P=0.81), which had mean levels of 36.42 and 36.6 mg/l before and after the operation, respectively [30].

In the current study, vitamin B 12 showed a significant decline after the OAGB procedure. Karbaschian and his colleagues agreed with our findings, as serum vitamin B 12 decreased from 205.83 at baseline to 194.86 pmol/l at the 16-week follow-up visit [37]. Other authors contradicted the previous findings, as OAGB as a revisional surgery was not associated with significant changes in serum vitamin B 12 levels (P=0.18) [30].

Calcium levels showed no significant changes after our OAGB as a revisional surgery procedure compared to the baseline level. In agreement with us, another study negated any significant calcium changes after OAGB, which had mean values of 8.8 and 8.7 mg/dl at baseline and one-year visit, respectively [38].

Our findings showed a significant improvement in the patient's lipid profile, as all of its harmful parameters showed a significant decline throughout the scheduled follow-up visits. In the same context, other authors reported an improvement or remission of the preexisting dyslipidemia in about 75% of patients following OAGB [26,27,39]. Additionally, other studies also reported decreased low-density lipoprotein [30,40], triglycerides [36,41], and cholesterol [42,43]. Heffron *et al.* attributed that decline to the improved insulin sensitivity secondary to effective weight loss [44].

Our findings showed that OAGB as a revisional surgery had a beneficial impact on 88.9% of diabetic cases at 1-year follow-up, and that was also evident by the significant decline of random blood sugar and HbA1C levels throughout the follow-up. Previous trials confirmed our findings regarding the excellent outcomes of diabetes after OAGB. Chiappetta *et al.* reported resolution of diabetes in 100% (7/7) of their diabetic cases one year after surgery [27], while Guenzi *et al.* reported an 88% rate for remission and a 12% rate for improvement after OAGB [45]. Despite the excellent results of diabetes management via OAGB, differences between studies could be explained by differences in follow-up durations and the definition of comorbidity resolution and/or improvement after bariatric surgery.

Our one-year follow-up showed the benefit of OAGB in in 80% of our hypertensive participants. This coincides with previous studies that reported around 70% resolution and/or improvement rates for the same comorbidity after OAGB [27,34,46].

Our study showed the excellent outcomes of reflux symptoms after OAGB as a revisional surgery, that stopped in 75% and improved in 25% of reflux cases one year after OAGB as a revisional surgery. Poublon *et al.* reported improvement or resolution of the same disease in 77.8% of their cases complaining of preoperative reflux [32]. Additionally, Musella *et al.* reported the beneficial impact of the same procedure on all reflux types, and they hypothesized that the procedure allows for early and easy passage of gastric contents to the jejunum. They also reported that that improvement is independent from weight loss [47].

All in all, our study supports the hypothesis that OAGB as a revisional surgery produces successful weight loss after failed restrictive procedures. Its efficacy is also reflected in the good management of obesity-related comorbidities, such as diabetes.

There are some limitations to the current investigation. It was a one-center study with a modestly included sample size. The study also lacks information on intermediate- and long-term follow-up. Therefore, these shortcomings should be adequately addressed in the next studies.

Conclusion

Based on the previous findings, laparoscopic OAGB as a revisional surgery appears to be a safe and efficacious procedure in the management of patients with failed previous restrictive procedures. It provides effective weight loss, comorbidity improvement, with no significant changes in nutritional outcomes.

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Conflicts of interest

There are no conflicts of interest.

References

1 Aboulghate M, Elaghoury A, Elebrashy I, Elkafrawy N, Elshishiney G, Abul-Magd E, *et al.* The burden of obesity in Egypt. Front Public Health 2021; 9:718978. https://doi.org/10.3389/fpubh.2021.718978

2 le Roux CW, Heneghan HM. Bariatric surgery for obesity. Med Clin North Am 2018; 102:165–182. https://doi.org/10.1016/j.mcna.2017.08.011

3 Nguyen NT, Varela JE. Bariatric surgery for obesity and metabolic disorders: state of the art. Nat Rev Gastroenterol Hepatol 2017; 14:160–169. https://doi.org/10.1038/nrgastro.2016.170

4 Furbetta N, Cervelli R, Furbetta F. Laparoscopic adjustable gastric banding, the past, the present and the future. Ann Transl Med 2020; 8 (Suppl 1):S4. https://doi.org/10.21037/atm.2019.09.17

5 Woźniewska P, Diemieszczyk I, Hady HR. Complications associated with laparoscopic sleeve gastrectomy – a review. Prz Gastroenterol 2021; 16:5–9. https://doi.org/10.5114/pg.2021.104733

6 Schouten R, Wiryasaputra DC, van Dielen FM, van Gemert WG, Greve JW. Long-term results of bariatric restrictive procedures: a prospective study. Obes Surg 2010; 20:1617–1626. https://doi.org/10.1007/s11695-010-0211-2

7 Benaiges D, Más-Lorenzo A, Goday A, Ramon JM, Chillarón JJ, Pedro-Botet J, *et al.* Laparoscopic sleeve gastrectomy: more than a restrictive bariatric surgery procedure? World J Gastroenterol 2015; 21:11804–11814. https://doi.org/10.3748/wjg.v21.i41.11804

8 Abdulrazzaq S, Elhag W, El Ansari W, Mohammad AS, Sargsyan D, Bashah M. Is revisional gastric bypass as effective as primary gastric bypass for weight loss and improvement of comorbidities? Obes Surg 2020; 30:1219–1229. https://doi.org/10.1007/s11695-019-04280-x

9 Frantzides CT, Alexander B, Frantzides AT. Laparoscopic revision of failed bariatric procedures. JSLS: J Soc Laparoendosc Surg 2019; 23: e2018.00074.

10 Altieri MS, Yang J, Nie L, Blackstone R, Spaniolas K, Pryor A. Rate of revisions or conversion after bariatric surgery over 10 years in the state of New York. Surg Obes Relat Dis 2018; 14:500–507. https://doi.org/10.1016/j.soard.2017.12.019

11 Rutledge R. The mini-gastric bypass: experience with the first 1,274 cases. Obes Surg 2001; 11:276–280. https://doi.org/10.1381/096089201321336584

12 Lee WJ, Ser KH, Lee YC, Tsou JJ, Chen SC, Chen JC. Laparoscopic Roux-en-Y vs. mini-gastric bypass for the treatment of morbid obesity: a 10-year experience. Obes Surg 2012; 22:1827–1834. https://doi.org/10.1007/s11695-012- 0726-9

13 Lee WJ, Yu PJ, Wang W, Chen TC, Wei PL, Huang MT. Laparoscopic Roux-en-Y versus mini-gastric bypass for the treatment of morbid obesity: a prospective randomized controlled clinical trial. Ann Surg 2005; 242:20–28. https://doi.org/10.1097/01.sla.0000167762.46568.98

14 Parmar CD, Mahawar KK. One anastomosis (mini) gastric bypass is now an established bariatric procedure: a systematic review of 12,807 patients. Obes Surg 2018; 28:2956–2967. https://doi.org/10.1007/s11695-018-3382-x

15 Rutledge R, Kular K, Manchanda N. The mini-gastric bypass original technique. Int J Surg 2019; 61:38–41. https://doi.org/10.1016/j.ijsu.2018.10.042

16 Noun R, Skaff J, Riachi E, Daher R, Antoun NA, Nasr M. One thousand consecutive mini-gastric bypass: short- and long-term outcome. Obes Surg 2012; 22:697–703. https://doi.org/10.1007/s11695-012-0618-z

17 Khrucharoen U, Juo YY, Chen Y, Dutson EP. Indications, operative techniques, and outcomes for revisional operation following mini-gastric bypass-one anastomosis gastric bypass: a systematic review. Obes Surg 2020; 30:1564–1573. https://doi.org/10.1007/s11695-019- 04276-7

18 Chevallier JM, Arman GA, Guenzi M, Rau C, Bruzzi M, Beaupel N, *et al.* One thousand single anastomosis (omega loop) gastric bypasses to treat morbid obesity in a 7-year period: outcomes show few complications and good efficacy. Obes Surg 2015; 25:951–958. https://doi.org/10.1007/s11695-014-1552-z

19 El Ansari W, Elhag W. Weight regain and insufficient weight loss after bariatric surgery: definitions, prevalence, mechanisms, predictors, prevention and management strategies, and knowledge gaps-a scoping review. Obes Surg 2021; 31:1755–1766. https://doi.org/10.1007/s11695-020- 05160-5

20 Nedelcu M, Khwaja HA, Rogula TG. Weight regain after bariatric surgery-how should it be defined? Surg Obes Relat Dis 2016; 12:1129–1130. https://doi.org/10.1016/j.soard.2016.04.028

21 Parrott J, Frank L, Rabena R, Craggs-Dino L, Isom KA, Greiman L. American society for metabolic and bariatric surgery integrated health nutritional guidelines for the surgical weight loss patient 2016 update: micronutrients. Surg Obes Relat Dis 2017; 13:727–741. https://doi.org/10.1016/j.soard.2016.12.018

22 AlTarrah D. Postoperative diet progression for laparoscopic sleeve gastrectomy. In: Al-Sabah S, Aminian A, Angrisani L, Al Haddad E, Kow L, editors. Laparoscopic Sleeve Gastrectomy. Cham: Springer International Publishing; 2021. 365–371. https://doi.org/10 1007/978-3-030-57373-7_35

23 Eid GM, Brethauer S, Mattar SG, Titchner RL, Gourash W, Schauer PR. Laparoscopic sleeve gastrectomy for super obese patients: forty-eight percent excess weight loss after 6 to 8 years with 93% follow-up. Ann Surg 2012; 256:262–265. https://doi.org/10.1097/SLA.0b013e31825fe905

24 Brethauer SA, Kim J, El Chaar M, Papasavas P, Eisenberg D, Rogers A, *et al.* Standardized outcomes reporting in metabolic and bariatric surgery. Obes Surg 2015; 25:587–606. https://doi.org/10.1007/s11695-015- 1645-3

25 Ghosh S, Bui TL, Skinner CE, Tan S, Hopkins G. A 12-month review of revisional single anastomosis gastric bypass for complicated laparoscopic adjustable gastric banding for body mass index over 35. Obes Surg 2017; 27:3048–3054. https://doi.org/10.1007/s11695-017-2887-z

26 Bruzzi M, Voron T, Zinzindohoue F, Berger A, Douard R, Chevallier JM. Revisional single-anastomosis gastric bypass for a failed restrictive procedure: 5-year results. Surg Obes Relat Dis 2016; 12:240–245. https://doi.org/10.1016/j.soard.2015.08.521

27 Chiappetta S, Stier C, Scheffel O, Squillante S, Weiner RA. Mini/one anastomosis gastric bypass versus Roux-en-Y gastric bypass as a second step procedure after sleeve gastrectomy-a retrospective cohort

study. Obes Surg 2019; 29:819–827. https://doi.org/10.1007/s11695-018-03629-y

28 Noun R, Slim R, Chakhtoura G, Gharios J, Chouillard E, Tohmé-Noun C. Resectional one anastomosis gastric bypass/mini gastric bypass as a novel option for revision of restrictive procedures: preliminary results. J Obes 2018; 2018:4049136. https://doi.org/10.1155/2018/4049136

29 Musella M, Bruni V, Greco F, Raffaelli M, Lucchese M, Susa A, *et al.* Conversion from laparoscopic adjustable gastric banding (LAGB) and laparoscopic sleeve gastrectomy (LSG) to one anastomosis gastric bypass (OAGB): preliminary data from a multicenter retrospective study. Surg Obes Relat Dis 2019; 15:1332–1339. https://doi.org/10.1016/j.soard.2019.05.026

30 Bashah M, Aleter A, Baazaoui J, El-Menyar A, Torres A, Salama A. Single Anastomosis Duodeno-ileostomy (SADI-S) Versus One Anastomosis Gastric Bypass (OAGB-OAGB) as Revisional Procedures for Patients with Weight Recidivism After Sleeve Gastrectomy: a Comparative Analysis of Efficacy and Outcomes. Obes Surg 2020; 30:4715–4723. https://doi.org/10.1007/s11695-020- 04933-2

31 Victorzon M. Revisional bariatric surgery by conversion to gastric bypass or sleeve-good short-term outcomes at higher risks. Obes Surg 2012; 22:29–33. https://doi.org/10.1007/s11695-011- 0548-1

32 Poublon N, Chidi I, Bethlehem M, Kuipers E, Gadiot R, Emous M, *et al.* One anastomosis gastric bypass vs. Roux-en-Y gastric bypass, remedy for insufficient weight loss and weight regain after failed restrictive bariatric surgery. Obes Surg 2020; 30:3287–3294. https://doi.org/10.1007/s11695-020-04536-x

33 Poghosyan T, Alameh A, Bruzzi M, Faul A, Rives-Lange C, Zinzindohoue F, *et al.* Conversion of sleeve gastrectomy to one anastomosis gastric bypass for weight loss failure. Obes Surg 2019; 29:2436–2441. https://doi.org/10.1007/s11695-019-03864-x

34 Debs T, Petrucciani N, Kassir R, Juglard G, Gugenheim J, Iannelli A, *et al.* Laparoscopic conversion of sleeve gastrectomy to one anastomosis gastric bypass for weight loss failure: mid-term results. Obes Surg 2020; 30:2259–2265. https://doi.org/10.1007/s11695-020-04461-z

35 Kular KS, Manchanda N, Rutledge R. Physiology of the OAGB: How it works for long-term weight loss. In: Deitel M, editor. Essentials of Mini - One Anastomosis Gastric Bypass. Cham: Springer International Publishing; 2018. 31–37. https://doi org/10.1007/978-3-319-76177-0_3

36 Zamaninour N, Pazouki A, Kermansaravi M, Seifollahi A, Kabir A. Changes in body composition and biochemical parameters following laparoscopic one anastomosis gastric bypass: 1-year follow-up. Obes Surg 2021; 31:232–238. https://doi.org/10.1007/s11695-020-04901-w

37 Karbaschian Z, Mokhtari Z, Pazouki A, Kabir A, Hedayati M, Moghadam SS, *et al.* Probiotic supplementation in morbid obese patients undergoing one anastomosis gastric bypass-mini gastric bypass (OAGB-OAGB) surgery: a randomized, double-blind, placebo-controlled, clinical trial. Obes Surg 2018; 28:2874–2885. https://doi.org/10.1007/s11695-018-3280-2

38 Nabil TM, Khalil AH, Mikhail S, Soliman SS, Aziz M, Antoine H. Conventional versus distal laparoscopic one-anastomosis gastric bypass: a randomized controlled trial with 1-year follow-up. Obes Surg 2019; 29:3103–3110. https://doi.org/10.1007/s11695-019- 03991-5

39 Kermansaravi M, Shahmiri SS, DavarpanahJazi AH, Valizadeh R, Berardi G, Vitiello A, *et al.* One anastomosis/mini-gastric bypass (OAGB/OAGB) as revisional surgery following primary restrictive bariatric procedures: a systematic review and meta-analysis. Obes Surg 2021; 31:370–383. https://doi.org/10.1007/s11695-020-05079-x

40 Carbajo MA, Fong-Hirales A, Luque-de-León E, Molina-Lopez JF, Ortiz-de-Solórzano J. Weight loss and improvement of lipid profiles in morbidly obese patients after laparoscopic one-anastomosis gastric bypass: 2-year follow-up. Surg Endosc 2017; 31:416–421. https://doi.org/10.1007/s00464-016-4990-y

41 Mahmoudieh M, Keleidari B, Afshin N, Sayadi Shahraki M, Shahabi Shahmiri S, Sheikhbahaei E, *et al.* The early results of the laparoscopic mini-gastric bypass/one anastomosis gastric bypass on patients with different body mass index. J Obes 2020; 2020:7572153. https://doi.org/10.1155/2020/7572153

42 Kessler Y, Adelson D, Mardy-Tilbor L, Ben-Porat T, Szold A, Goitein D, *et al.* Nutritional status following one anastomosis gastric bypass. Clin Nutr 2020; 39:599–605. https://doi.org/10.1016/j.clnu.2019.03.008

43 Bettini S, Segato G, Prevedello L, Fabris R, Prà CD, Zabeo E, *et al.* Improvement of lipid profile after one-anastomosis gastric bypass compared to sleeve gastrectomy. Nutrients 2021; 13:8. https://doi.org/10.3390/nu13082770

44 Heffron SP, Parikh A, Volodarskiy A, Ren-Fielding C, Schwartzbard A, Nicholson J, *et al.* Changes in Lipid Profile of Obese Patients Following Contemporary Bariatric Surgery: A Meta-Analysis. Am J Med 2016; 129:952–959. https://doi.org/10.1016/j.amjmed.2016.02.004

45 Guenzi M, Arman G, Rau C, Cordun C, Moszkowicz D, Voron T, *et al.* Remission of type 2 diabetes after omega loop gastric bypass for morbid obesity. Surg Endosc. 2015; 29:2669–2674. https://doi.org/10.1007/s00464-014-3987-7

46 Chevallier J-M. Effects of OAGB on obesity-related co-morbidities: lipids, hypertension, non-alcoholic fatty liver, etc. In: Deitel M, editor. Essentials of Mini - One Anastomosis Gastric Bypass. Cham: Springer International Publishing; 2018. 111–117. https://doi.org/10.1007/978-3-319-76177-0_12

47 Musella M, Vitiello A, Berardi G, Velotti N, Pesce M, Sarnelli G. Evaluation of reflux following sleeve gastrectomy and one anastomosis gastric bypass: 1-year results from a randomized open-label controlled trial. Surg Endosc 2021; 35:6777–6785. https://doi.org/10.1007/s00464-020-08182-3