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Original article

Laparoscopic stomach intestinal pylorus-sparing surgery as a revisional option after failed adjustable gastric banding: a report of 27 cases with 36-month follow-up

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Abstract

Background: Inadequate weight loss, weight recidivism, and device-related complications after an adjustable gastric banding (AGB) can be treated by a laparoscopic conversion to stomach intestinal pylorus-sparing surgery (SIPS).

Objective: The aim of the study was to analyze the midterm outcomes of revision SIPS surgery after failed AGB.

Setting: Private practice, United States.

Methods: This is a retrospective review of our prospectively collected data of patients who underwent laparoscopic conversion from AGB to SIPS surgery from June 2013 and February 2017 by a single surgeon in a single institution.

Results: Twenty-seven patients (1 stage: 22 and 2 stage: 5) underwent a laparoscopic revision of AGB to SIPS surgery. The mean ± standard deviation preoperative body mass index (BMI) before AGB was 47.5 ± 6.8 kg/m^2, while the mean nadir BMI after AGB was 36 ± 7.7 kg/m^2. The overall time to reoperation was 9.3 ± 8.7 and 5.6 ± 2.5 years in 1- and 2-stage conversion patients, respectively. The mean preoperative BMI before revision SIPS surgery was 46.7 ± 7 kg/m^2. At 36 months, the patients had an average change in BMI of 20.9 units with 90% excess weight loss. A major complication occurred in 4 patients. Postoperatively, the fasting blood glucose, insulin, low-density lipoprotein, triglyceride, and most of the co-morbidities were resolved or improved.

Conclusion: This study demonstrates that conversion of failed AGB to SIPS surgery is an effective approach to AGB failure. (Surg Obes Relat Dis 2018;14:1139–1148.)

Keywords: Stomach intestinal pylorus-sparing surgery; SIPS surgery; Failed adjustable gastric banding; Weight regain; Bariatric; Revision

There are now a multitude of studies that demonstrate the high incidence weight recidivism and long-term complications in adjustable gastric banding (AGB) [1–6]. To date, several authors have reported their approach to dealing with this often complex problem with sleeve gastrectomy (SG), Roux-en-Y gastric bypass (RYGB), mini-gastric bypass (MGB), and biliopancreatic diversion with duodenal switch (BPD-DS) [7–10]. Controversy currently exists regarding the best choice for patients once they require removal of the AGB.

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In 2013, our group began performing a modification of the traditional duodenal switch (DS) using a single anastomosis instead of a Roux-en-Y reconstruction with the sleeve done over a 40- to 42-Fr bougie [11,12]. This modification was named the stomach and intestinal pylorus-sparing (SIPS) surgery. We have used this surgery in the past for patients who have failed the RYGB [13]. However, the outcomes of SIPS surgery in patients with failed AGB are still unknown.

We report our preliminary experience with 1- and 2-stage revision SIPS surgery in patients who had AGB as their primary surgery. We have also compared the outcomes between 1- and 2-stage revision SIPS surgery, and the outcomes between the nonresponders (insufficient weight loss or weight regain) and AGB complication group. This is the first report in the literature that reports the outcomes of SIPS surgery after failed AGB.

Methods

After obtaining an institutional review board approval, we searched our database from June 2013 through February 2017. The failure of AGB was defined as not losing or not maintaining >50% weight loss at 18 months or having a slip postoperatively. The patients who met the criteria for AGB failure were given various revision surgery options; after detailed discussion with the surgeon, the patients chose to undergo laparoscopic SIPS surgery.

Because the International Federation has only declared the SIPS surgery not investigational for the Surgery of Obesity and not the American Society for Metabolic and Bariatric Surgery, we chose to alter our preoperative consent process [14]. Our consent process includes a discussion of the papers present in the literature as well as the differences between a Roux-based DS and a single anastomosis DS. Finally, the patient signs a specific consent for single anastomosis DS that includes a specific diagram of the proposed operation.

A multidisciplinary team (nutritionist, psychologist, and surgeon) routinely evaluated each patient preoperatively. The relevant information included demographic characteristics, indication for conversion, time from the AGB to the SIPS surgery, operative time, length of hospital stay, morbidity and mortality rates, nutritional data, co-morbidity data, and weight loss data. Co-morbidities included were, type 2 diabetes (T2D), hypertension (HTN), obstructive sleep apnea, and gastroesophageal reflux disease (GERD). Presence of co-morbidity was based on medication use or a positive sleep study. A single surgeon at a single private institution performed all operations. The patients were followed-up at our office clinic at 1, 3, 6, and 12 months postoperatively and yearly after that to assess weight loss, complications, and mortality.

The patients underwent either 1- or 2-stage revision SIPS surgery. The method of a 1- or 2-stage operation depends on the surgeon's preference, reasons for band removal, and overall patient safety. One-stage revision SIPS surgery consisted in removing the AGB and performing the laparoscopic SIPS procedure simultaneously. Two-stage revision SIPS surgery consisted in removing ABG and interval conversion to laparoscopic SIPS surgery.

Statistical methods

Patients had their weight loss modeled on a nonlinear regression curve. Patients then had their weight loss interpolated at 12, 18, 24, and 36 months. A patient data for each interpolated weight loss was only included if the individual regression had an r^2 value >.95 (simply, this means that at most 5% of the weight loss cannot be explained by time since the operation, but by extraneous variables). At each time interval, weight loss was measured, and then averages and standard deviations were calculated. Weight loss results were then compared using *t* tests.

Nutritional data and complications were gathered for each patient; χ^2 tests, Fisher exact tests, and z tests were then run to compare the nutritional rates between the 2 procedures.

All statistical analyses were run through SigmaPlot™ (Systate Software Inc., headquartered in San Jose, CA) statistical software.

Surgical technique

For the single-stage approach, we first removed the lapband port (Fig. 1). Once this was accomplished, the ileocecal valve was located, and then the small bowel was traced retrograde to 300 cm and brought up and tacked to the gastrocolic omentum. We then took down adhesions from the old band and removed the old band and the adhesions under the band. At this point, we were able to begin the dissection to the lesser sac and then sequentially fire a Gastrointestinal Anastomosis (Covidien, Minneapolis, MN) stapler 5 cm from the pylorus, onto the stomach approximately 1.5 cm, and then fire up the greater curve of the stomach after a sizing tube (40-Fr bougie) from the Allergan Corporation. We then brought this all the way up to the angle of His, and after we had created a long sleeve, we then looked over the entire staple line to make sure that there were no places that were narrowed at all, and there were no places where there were staple line problems. The stomach was taken out of the abdominal cavity. We then dissected free the duodenal bulb 3 cm from the pylorus circumferentially and transected it using a Gastrointestinal Anastomosis stapler [15]. We then oversewed the duodenal stump using PDS (Polydioxanone) suture. Next, we brought up the loop limb and sewed it to the duodenal stump using 2.0 polysorb (Medtronic, Minneapolis, MN, USA). Enterotomies were made in both limbs, and 3.0 polysorb was used to do another posterior row. An anterior row was also done using 3.0 polysorb.

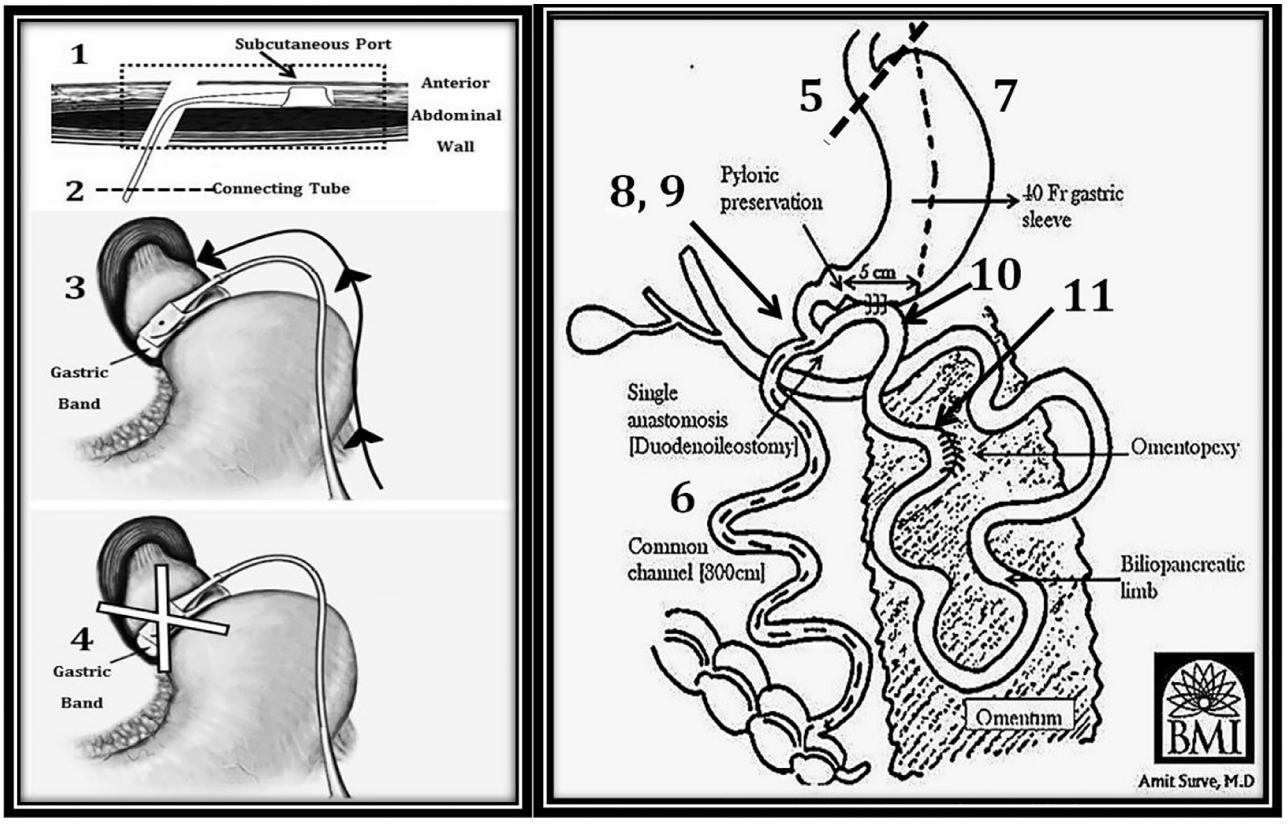

Fig. 1. Hand-drawn sketch of a step-by-step technique of conversion of previous laparoscopic adjustable gastric band to laparoscopic stomach intestinal pylorus-sparing surgery.

The potential space underneath the loop was not closed with a suture. Other 2-interrupted sutures were placed; one from the afferent limb to the antrum (antiobstruction) and the other from the afferent limb to the omentum (antivolvulus) to prevent chronic nausea and volvulus, respectively [16]. The bowel was inspected for bleeding and bowel damage. The skin was closed with staples.

For patients who underwent a 2-stage procedure, a similar approach was used.

Statement of Human and Animal Rights

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Since this is a retrospective study, formal consent is not required for this type of study.

Results

Twenty-seven patients qualified for the study. Twenty-two patients underwent 1-stage revision SIPS surgery while 5 patients underwent 2-stage revision SIPS surgery. Of the 5 patients who underwent 2-stage revision SIPS surgery, 3 of the patients had the bands removed by other surgeons and then were referred to our practice for revisions. Also, there were 9 patients in the nonresponders group and 18 patients in the AGB complication group.

Twenty-four patients, 13 patients, and 10 patients are beyond the 1-, 2-, and 3-years postoperative marks, respectively. The rates of visit completion according to the follow-up time point were 88%, 90.4%, 94.1%, and 70% at 12, 18, 24, and 36 months, respectively. No patients were lost to follow-up. See Table 1 for the demographic data. The indications for revision SIPS surgery were weight recidivism with device-related complication (55.5%), weight recidivism or weight loss failure (33.3%), and weight recidivism along with device intolerance (11.1%). The mean time to revision was 8.6 ± 8 years. The mean operating time, blood loss, and length of stay were 90.9 ± 21.6 minutes, 15.8 ± 22.5 mL, and 2.4 ± 2.7 days, respectively. All the cases were completed laparoscopically. However, 3 and 2 patients required readmission and reoperation within the first 30 days of intervention, respectively (Table 2). No death was noted within the first 30 days of intervention. Most of the 30-days readmission, reoperation, and emergency department visits were seen in the AGB complication group (n = 18): 2 patients required readmission, 2 patients required reop-

Table 1
Demographic and anthropometric characteristics of the patients.

Characteristic	1 stage	2 stage	*P* value	Total
Available data for primary AGB				
Patient (N)	19	5	-	24
Male/female, n	3/16	1/4	1	4/20
Preoperative weight, lbs*	302.4 ± 56.9	286.2 ± 49.7	.563	299.6 ± 55
Preoperative BMI, kg/m^2*	47.9 ± 6.6	45.9 ± 8	.561	47.5 ± 6.8
Nadir weight, lbs*	228 ± 52.9	206 ± 38.5	.391	223.8 ± 50.4
Nadir BMI, kg/m^2*	36.4 ± 8.1	34.4 ± 6.7	.614	36 ± 7.7
Weight regained from the nadir weight, lbs*	68.7 ± 58.3	68.7 ± 55.2	1.000	68.7 ± 56.5
BMI regained from the nadir BMI, kg/m^2*	10.7 ± 9	11.1 ± 8.8	.929	10 ± 8.9
Band repaired/replaced	6	0	.555	6
Revision SIPS surgery				
Patient (N)	22	5	-	27
Male/female, n	3/19	1/4	1	4/23
Age, yr*	47.4 ± 10.6	49.2 ± 14.9	.753	47.7 ± 11.2
Time to reoperation, yr*	9.3 ± 8.7	5.6 ± 2.5	.819	8.6 ± 8
Rx intent: weight loss, n (%)†	8 (29.6)	1 (3.7)	-	9 (33.3)
Rx intent: mixed, n (%)‡	14 (51.8)	4 (14.8)	-	18 (66.6)
Follow-up, mo*	19.4 ± 11.4	30.3 ± 9.8	.052	21.4 ± 11.7
Preoperative weight, lbs*	294.1 ± 60.2	275.6 ± 52.6	.533	290.6 ± 58.4
Preoperative BMI, kg/m^2*	46.9 ± 7.2	45.6 ± 6.7	.716	46.7 ± 7
Ideal weight, lbs*	132.3 ± 18.4	129 ± 12.3	.708	131.7 ± 17.3
Excess weight, lbs*	161.7 ± 48.9	146.6 ± 48.6	.538	158.9 ± 48.3
vASA score*	3 ± .2	3 ± 0	1.000	3 ± .2

AGB = adjustable gastric band; BMI = body mass index; SIPS = stomach intestinal pylorus-sparing surgery; Rx = prescription; ASA = American Society of Anesthesiologists.

There were no significant between-group differences in the characteristics at baseline.

* Values expressed as mean ± standard deviation.

† Include nonresponders (weight recidivism or weight loss failure).

‡ Include weight recidivism along with ABG complication group.

Table 2
Perioperative technical outcomes and 30-day rate readmission and reoperation.

Operative details	1 stage	2 stage	*P* value	1 and 2 stage
Patient (N)	22	5	-	27
Operating time (skin-to-skin), min*	92.7 ± .5	84.3 ± 29	.450	90.9 ± 21.6
Open conversion, n	0	0	1.000	0
Blood loss, cc*	15.8 ± 23.8	16 ± 19.4	.986	15.8 ± 22.5
Length of stay, d*	2.4 ± 2.9	2.2 ± 1	.882	2.4 ± 2.7
30 d of index hospitalization				
Readmission, n (%)	3 (13.6)	0	1.000	3 (11.1)
Reoperation, n (%)	2 (9)	0	1.000	2 (7.4)
Emergency department visit, n (%)	1 (4.5)	0	1.000	1 (3.7)
Death, no. (%)	0	0	1.000	0

There was no statistically significant difference between the operative details of 1- and 2-stage revision stomach intestinal pylorus-sparing surgery procedures. In total, 3 patients required readmission, and 2 patients required reoperation during the first 30 days of intervention.

* Values expressed as mean ± standard deviation.

eration, and 1 patient required an emergency department visit within the first 30 days of intervention. In the nonresponder group (n = 9), only 1 patient required readmission within the first 30 days of intervention.

Complications

Short- and long-term morbidity was defined as those occurring at <30 or >30 days, respectively. There were 11 short-term (n = 11/27) and 7 long-term complications (n = 7/27; Table 3). The Clavien-Dindo scale was used for the description of complications. In total, 18 postoperative complications occurred with revision SIPS surgery. Of the 18 complications, 7 complications (25.9%) were grade I, 5 complications (18.5%) were grade IIIb, and 4 complications (14.8%) were grade II.

Short-term complication

Number of patients

Ten patients (37%) experienced short-term complication with revision SIPS surgery (8 patients [36.3%] with 1-stage

Table 3
Short- and long-term complication with 1- and 2-stage revision SIPS surgery.

1-stage (N = 22)	P, n	ASA Score	Short-term complication				Long-term complication			
			Minor		Major		Minor		Major	
			Event	n	Event	n	Event	n	Event	n
	1	3	-	-	Gastric staple line leak	1	Diarrhea	1	-	-
	1	3	-	-	Abdominal hematoma	1	-	-	Hiatal hernia	1
									Ventral hernia	1
									Chronic diarrhea	1
	3	3	Trocar site infection	3	-	-	-	-	-	-
	1	3	-		SMVT	1	-	-	-	-
	1	4	Panniculitis	1	-	-	-	-	-	-
			Acute renal failure	1						
	1	3	-	-	Leak	1	-	-	-	-
	1	3	-	-	-	-	Chronic diarrhea	1	-	-
TE			-	5	-	4	-	2	-	3
TP		8 (4 minor, 4 major)					3 (2 minor, 1 major)			
2-stage (N = 5)	P (no.)	ASA score	Short-term complication				Long-term complication			
			Minor		Major		Minor		Major	
			Event	n	Event	n	Event	n	Event	n
	1	3	Gastrointestinal Ileus	1	-	-	Clostridium difficile infection	1	-	-
							Symptomatic cholelithiasis	1		
	1	3	Nausea and vomiting	1	-	-	-		-	-
TE			-	2	-	0	-	2	-	0
TP			2 (1 minor, 1 major)				1 (1 minor)			

SIPS = stomach intestinal pylorus-sparing surgery; P = patient; ASA = American Society of Anesthesiologists; SMVT = superior mesenteric venous thrombosis; TE = total number of events; TP = total number of patients.

revision SIPS surgery versus 2 patients [40%] with 2-stage revision SIPS surgery; $P > .999$).

Number of events

The total short-term complication rate with revision SIPS surgery was 40.7% (9 events [40.9%] with 1-stage revision SIPS surgery versus 2 events [40%] with 2-stage revision SIPS surgery).

Nonresponders and AGB complication group

Of the 9 patients from the nonresponders group, 1 patient (11.1%) experienced 2 short-term complications (22.2%). Among the AGB complication group (18 patients), 8 patients (44.4%) experienced 8 short-term complications (44.4%).

Overall, 10 patients experienced short-term complications. In this study, 26 patients had an American Society of Anesthesiologists score of 3. There was only 1 patient with an American Society of Anesthesiologists score of 4 who experienced an acute renal failure, which was managed with intravenous fluids without any need for dialysis. The same patient also experienced panniculitis, which was treated with intravenous antibiotics. There were 2 leaks in the 1-stage group. Of 2 patients, 1 patient developed a leak at some of the scar tissue associated with taking down the AGB. One patient experienced superior mesenteric venous thrombosis on a postoperative day 29.

Long-term complication

Number of patients

Four patients (14.8%) experienced long-term complication with revision SIPS surgery (3 patients [13.6%] with 1-stage revision SIPS surgery versus 1 patient [20%] with 2-stage revision SIPS surgery; $P = 1.000$).

Number of events

The total long-term complication rate with revision SIPS surgery was 25.9% (5 events [22.7%] with 1-stage revision

Table 4
Intraabdominal operations, other related procedures, and annual rate of reoperation.

Surgery type	Procedure	1 stage		2 stage		TP n (%)	TE n (%)
		P n (%)	E n (%)	P n (%)	E n (%)		
Minor surgery	UGI*	1 (4.5)	1 (4.5)	0	0	1 (3.7)	1 (3.7)
	EGD*	1 (4.5)	1 (4.5)	0	0	1 (3.7)	1 (3.7)
	Colonoscopy*	1 (4.5)	1 (4.5)	0	0	1 (3.7)	1 (3.7)
Total	-	3 (13.6)	3 (13.6)	0	0	3 (11.1)	3 (11.1)
Major surgery	Exploratory laparoscopy*	1 (4.5)	1 (4.5)	0	0	1 (3.7)	2 (7.4)
			1 (4.5)			1 (3.7)‡	
	CCL†		1 (4.5)	0	0		1 (3.7)
	HHR*	1 (4.5)‡	1 (4.5)	0	0		1 (3.7)
	VHR*		1 (4.5	0	0		1 (3.7)
Total	-	2 (9)	5 (22.7)	0	0	2 (7.4)	5 (18.5)
Reoperation rate per yr of follow-up (major surgery)							
Yr	1 stage		2 stage			TP n (%)	TE n (%)
	P n (%)	E n (%)	P n (%)	E n (%)			
1	2 (9)	5 (22.7)	0	0		2 (7.4)	5 (18.5)
2	0	0	0	0		0	0
3	0	0	0	0		0	0

P = patient; E = event; TP = total number of patients; TE = total number of events; UGI = upper gastrointestinal series; EGD = esophageal gastro duodenoscopy; CCL = common channel lengthening; HHR = hiatal hernia repair; VHR = ventral hernia repair.

* Surgery performed to treat complication that can occur with any weight loss surgery.

† Surgery performed to treat complication that can occur specifically with revision stomach intestinal pylorus-sparing surgery.

‡ The patient had a CCL, HHR, VHR, and an exploratory laparoscopy as well.

SIPS surgery versus 2 events [40%] with 2-stage revision SIPS surgery).

Nonresponders and AGB complication group

Of the 9 patients from the nonresponders group, none (0%) experienced a long-term complication. Among the AGB complication group (18 patients), 4 patients (22.2%) experienced 7 short-term complications (38.8%).

Overall, 1 patient underwent common channel lengthening for chronic diarrhea. Our technique of common channel lengthening after SIPS surgery has been previously described in one of the video reports [11].

Intraabdominal operation and annual rate of reoperation

Three patients underwent minor surgery, and 3 patients underwent major surgery after revision SIPS surgery. Two patients required reoperation within the first year, and none of our patients required reoperation within the second and third year after revision SIPS surgery (Table 4). None of the patients in the nonresponders group required minor or major reoperation.

Weight loss

The mean preoperative body mass index (BMI) before revision SIPS surgery was 46.7 ± 7 kg/m^2.

1-stage revision SIPS surgery

At 12, 18, 24, and 36 months, the patients had an average change in BMI of 15.1 ± 5.4, 16.4 ± 5.9, 17.8 ± 6.6, and 22.8 ± 5.3 units, respectively. Similarly, at 12, 18, 24, and 36 months, the patients lost an excess weight of 73.6 ± 18.8%, 81.7 ± 21.4%, 84.8 ± 21.3%, and 91.3 ± 16.4%, respectively.

2-stage revision SIPS surgery

At 12, 18, 24, and 36 months, the patients had an average change in BMI of 15.5 ± 4.5, 16.8 ± 4.9, 17.4 ± 5.4, and 16.1 ± .3 units, respectively. Similarly, at 12, 18, 24, and 36 months, the patients lost an excess weight of 79.4 ± 25.7%, 85.6 ± 26.3%, 87.5 ± 24.1%, and 86.7 ± 32.2%, respectively.

According to BMI over time, change in BMI, percent excess weight loss (EWL), and percent total weight loss, there was a statistically significant difference between the weight loss of 1-stage revision SIPS surgery and 2-stage revision SIPS surgery at 12, 18, 24, and 36 months.

1- and 2-stage revision SIPS surgery

Overall, at 1, 2, and 3 years, the patients lost 74.9 ± 20% and 85.6 ± 21.4% and 90 ± 18.9% of excess weight with revision SIPS surgery after failed AGB, respectively. See Fig. 2 for BMI over time.

Nutritional status

We compared the nutritional outcomes (number of patients with abnormal values as well as means) between baseline and 12 months (Table 5). At 12 months, the labs were available for 17 patients (70.8%). The number of patients with an abnormal preoperative low-density

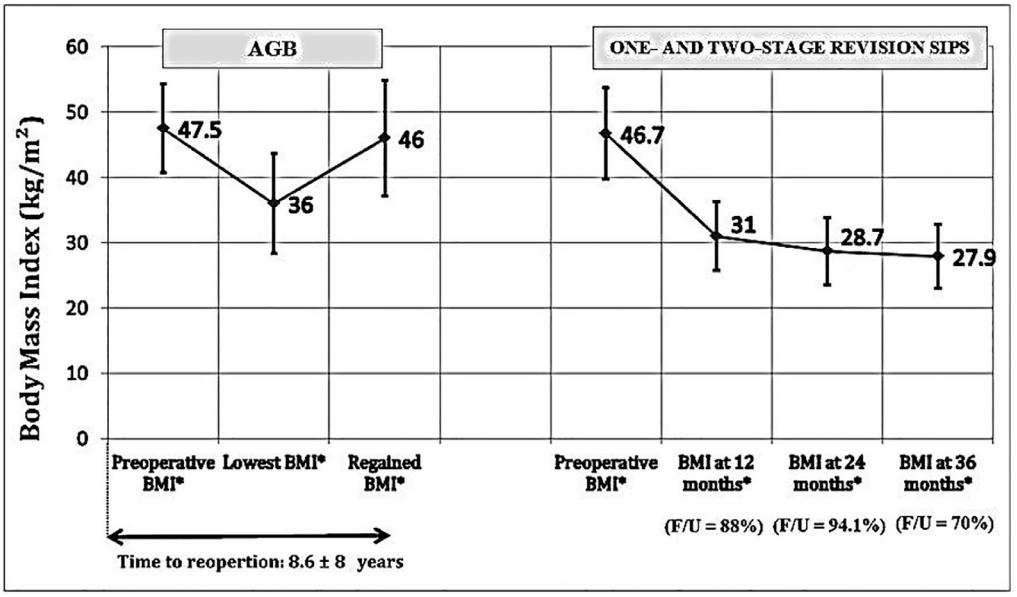

Fig. 2. Demonstrates average body mass index over time with previous adjustable gastric band and revision 1- and 2-stage stomach intestinal pylorus-sparing surgery.

lipoprotein value was significantly reduced after SIPS surgery ($P = .002$; 12 versus 1 patient). Postoperatively, the fasting blood glucose, insulin, low-density lipoprotein, and triglyceride improved. The mean postoperative total protein was significantly lower than the mean preoperative total protein ($P < .001$). However, the mean pre- and postoperative total protein values were in normal range (preoperative, 7.1 ± .6 g/dL versus postoperative, 6.1 ± .7 g/dL).

Obesity-related co-morbidity

Complete remission of T2D, HTN, obstructive sleep apnea, and GERD was defined as follows: normal measures of glucose metabolism in the absence of antidiabetic medications; being normotensive and off antihypertensive medication; discontinuation of continuous positive airway pressure; and absence of symptoms and discontinuation of GERD medication, respectively [17]. Complete remission of T2D, HTN, obstructive sleep apnea, and GERD was seen in 75%, 54.5%, 77.7%, and 66.6%, respectively. The mean postoperative follow-up period was 21.4 months (Table 6).

Discussion

Perhaps the strongest limitation of this research lies with its small numbers. Without larger numbers, it is impossible to make accurate assumptions about our complication rates. Our 2 leaks were the only leaks in our entire AGB to sleeve experience in >100. We cannot say how performing SIPS surgery contributed to these leaks because they both were at the site of the connective tissue rind underneath the band. Only 1 of our complications was unique to SIPS surgery, and that was chronic diarrhea. That was remedied with common channel lengthening [18]. This complication had nothing to do with the removal of the lap band. Other questions will arise why some were done in 2 stages rather than 1. Some patients had severe scar tissue and it was not safe to do in 1 setting. Others had their band removed by other surgeons and then were referred to our practice for revisions.

We can definitively say that our weight loss after removal of the AGB mirrors our weight loss for SIPS surgery done as a primary procedure [12]. In all patients, desired weight loss was achieved at the end of 3 years. The obesity-related diseases were resolved in 66.6% patients, while 18.1% patients had an improvement.

The AGB has certainly become less popular over the last few years because of insufficient weight loss and device-related complications. Long-term studies have demonstrated a high incidence of long-term complications [1,2]. A study that had a 100% follow-up at a mean of 14 years showed that the band removal rate was almost 50% [3]. In a series of 82 laparoscopic AGB (LAGB) patients, nearly 60% required reoperation [4]. Carandina et al. [5] showed a revision rate of 56.3 % at 10 years after LAGB. Arapis et al. [6] reported a failure rate of 70% beyond 15 years. Among the complications that require revisional surgery after AGB, the most common was band dislocation secondary to slippage and/or pouch dilation.

Revisional surgery is technically challenging, with longer operative times and higher complication rates compared with the primary bariatric procedure. There have

Table 5
Nutritional outcomes with 1- and 2-stage revision SIPS surgery at 12 months.

Nutrient	Preoperative n (%): 20/24, (74)			Postoperative n (%): 17/24, (70.8)		*P* value (pre-versus postabn)	*P* value (pre-versus postmean)
	Abn n (%)	Mean ± SD	Normal range	Mean ± SD	Abn n (%)		
Vitamin A	0	43.6 ± 6.9	20–65 μg/dL	44.6 ± 15.6	0	1	.797
Vitamin D	12 (60)*	30.3 ± 13.5	32–100 ng/mL	31.2 ± 9.2	7 (41.1)*	.417	.817
Vitamin E	1 (5)*	7.9 ± 4.5	5.5–18 mg/L	9.3 ± 2.2	1 (5.8)*	1	.251
Vitamin K	0	0.8 ± .5	.13–1.8 ng/mL	0.5 ± .4	0	1	.054
Vitamin B1	2 (10)*	119.1 ± 49.5	66.5–200 nmol/L	120.2 ± 42.8	1 (5.8)*	1	.943
Vitamin B12	0	705.6 ± 495.9	211–911 pg/mL	907 ± 578.1	1 (5.8)*	.459	.262
Folate	0	18.1 ± 15.1	5.38–24 ng/mL	14.3 ± 9.9	0	1	.381
Iron	0	58.6 ± 18.9	30–150 μg/dL	82.2 ± 51.1	0	1	.063
Ferritin†	3 (15)*	59.8 ± 58.8	12–150/300 ng/mL	119.4 ±116.8	7 (41.1)*‡	.136	.053
Zinc	0	76.2 ± 21.5	56–134 μg/dL	74.8 ± 20.1	2 (11.7)*	.204	.840
Copper	0	136.4 ± 19	72–166 μg/dL	111 ± 46	3 (17.6)*	.088	.030
Sodium	0	138.9 ± 2.5	132–146 mmol/L	141 ± 2.4	0	1	.014
Potassium	0	4.3 ± .6	3.5–5 mmol/L	4 ± .4	0	1	.088
Chloride	0	105.3 ± 2.3	99–111 mmol/L	107.1 ± 3.5	0	1	.069
Insulin	4 (20)‡	23.3 ±18.8	2–23 mU/L	5.8 ± 3.8	1 (5.8)*	.348	**<.001**
Glucose	8 (40)‡	97.9 ± 14.2	65–100 mg/dL	83 ± 7.8	1 (5.8)‡	.023	**<.001**
HbA1C	2 (10)‡	5.5 ± .5	4%–6%	5 ± .6	1 (5.8)‡	1	.009
TSH	2 (10)*‡	2.1 ±1.3	.5–4.7 μIU/mL	1.5 ± 1	1 (5.8)*	1	.130
PTH	1 (5)‡	61.1 ± 35.5	10–65 pg/mL	72.9 ± 28.9	7 (41.1)‡	.014	.281
Calcium	0	9.3 ±0.4	8.7–10.4 mg/dL	9 ± .3	2 (11.7)	.204	.016
Creatinine	0	.8 ± .1	.50–1.2 mg/dL	.7 ± .1	0	1	.005
Cholesterol	4 (20)‡	174.7 ± 36	100–199 mg/dL	154.3 ± 23.4	0	.109	.053
Triglyceride	6 (30)‡	134.8 ± 60.3	40–150 mg/dL	82.6 ± 31.1	1 (5.8)‡	.097	**.003**
HDL	3 (15)*	51.9 ± 13.9	40–96 mg/dL	59.7 ± 24	1 (5.8)*	.609	.226
LDL	12(40)‡	102.2 ± 39.1	0–99 mg/dL	82.7 ±17.1	1(5.8)*	**.002**	.065
Prealbumin	1 (5)*	19.2 ± 7.3	11–34 mg/dL	20 ± 4.6	0	1	.699
Albumin	0	3.9 ± .3	3.2–4.8 g/dL	3.7 ± .4	2 (11.7)*	.204	.091
Total protein	0	7.1 ± .6	6–8.4 g/dL	6.1 ± .7	5 (29.4)*	.014	**<.001**

SIPS = stomach intestinal pylorus-sparing surgery; Abn = abnormal; SD = standard deviation; HbA1C = glycated hemoglobin; TSH = thyroid stimulating hormone; PTH = parathyroid hormone; HDL = high-density lipoprotein; LDL = low-density lipoprotein.

Data were presented as the number of patients with abnormal labs with mean ± SD at pre- and postoperative.

Bolded *P* values implies that the difference is statistically significant.

* Number of patients with abnormally low values.

† For males and females, we considered the serum ferritin value of 12–300 ng/mL and 12–150 ng/mL, respectively.

‡ Number of patients with abnormally high values.

Table 6
Full and durable remission of coexisting conditions associated with obesity in 27 patients after revision SIPS surgery with a mean follow-up of 21.4 months.

Condition	Baseline n	Postoperative data available n	R n (%)	I n (%)	N n (%)
HTN	13	11	6 (54.5)	5 (45.4)	-
OSA	12	9	7 (77.7)	-	2 (22.2)
T2D	4	4	3 (75)	1 (25)	-
GERD	12	9	6 (66.6)	-	3 (33.3)
Total	41	33	22 (66.6)	6 (18.1)	5 (15.1)

SIPS = stomach intestinal pylorus sparing surgery; R = remitted; I = improved; N = neutral; HTN = hypertension; OSA = obstructive sleep apnea; T2D = type 2 diabetes; GERD = gastroesophageal reflux disease.

The OSA, DM, GERD, and HTN resolution rates after revision SIPS surgery were 77.7%, 75%, 66.6%, and 54.5% respectively. Similarly, DM and HTN improved in 45.4% and 25% patients, respectively. Also, none of the coexisting conditions associated with obesity worsened in any of the patients.

been a few studies that have not only reported the short- and long-term outcomes of conversion of failed AGB to SG, RYGB, DS, or MGB but also compared the outcomes of these conversions. For instance, at 2 years 1 study found that the mean EWL in patients who were converted from AGB to SG or RYGBP was 65% and 62%, respectively [19]. Several studies favor SG over RYGB [7] after failed LAGB, while there are some reports that conclude that SG is not a favorable option after failed AGB due to high complication rates [20,21]. Another study by

Dakour Aridi et al. [22] found RYGB after failed AGB achieved 61.2% EWL at 60 months. Although there are no published series that report nutritional complications after revision LAGB to RYGB, nutritional deterioration after primary RYGB is evident [23]. It results from the reduced oral intake or excessive losses secondary to the reconfiguration of the gastrointestinal tract. Thus, it becomes necessary to preserve at least a 3-m-long common channel (seen with SIPS) to prevent malnutrition after RYGB.

There are very few reports on failed LAGB to BPD-DS. Although BPD-DS is considered the most effective bariatric surgery, most surgeons do not perform BPD-DS due to its technical difficulties and nutritional complications that are seen postsurgery. Poyck et al. [10] reported promising weight loss post-LAGB BPD-DS but had increased nutritional deficiencies. Despite the dietary advice and nutritional supplementation, not all deficiencies resolved. In this present study, we did not see any deficiencies at 36 months and all the lab values postoperatively were within normal range. We believe the longer common channel and the elimination of the Roux limb in SIPS surgery are the primary reasons for less nutritional deficiencies compared with BPD-DS. Elnahas et al. [24] showed 78.4% EWL at the end of 2 years with conversion to DS. Rutledge [9] showed a mean of 79% at 1 year when converted to MGB. The SIPS, standard DS, and MGB all seem to be better options for patients after failure of AGB. However, all these approaches would benefit from confirmatory studies. None of the approaches have enough numbers to make definitive statements on complications.

The other hallmark of this study was the resolution of co-morbidities. At 36 months, the T2D remission rate was 75%. There are many reasons for the high T2D remission rate seen after SIPS surgery, such as bypass of duodenopancreas, moderate gastric restriction, a rapid entrance of undigested chime into the distal intestine, and maintenance of weight loss. The systemic review and meta-analysis conducted by Sharples et al. [25] on the outcomes of failed AGB to RYGB or SG showed the rate of remission of T2D and HTN were 46.5% and 35.9%, respectively [25]. These rates are lower than the ones reported in our study. Also, lower remission rates along with higher recurrence rates were observed with RYGB and SG [26,27]. Our results demonstrate that conversion of failed AGB to SIPS was superior in terms of nutritional status and co-morbidities resolution compared with other bariatric surgeries. However, we cannot deny the fact that these results are not conclusive as they were derived from a small group of patients.

Some limitations are noteworthy. First, it is retrospective in nature. Second, as we mentioned earlier, the overall cohort included 27 patients. Also, we had only 5 patients in the 2-stage group. Third, a few patients lacked information about their AGB as these patients had their bands placed, repaired, replaced, or removed outside our center. All patients with failed AGB were included in the study, regardless of the band type, the method of insertion, and the interval conversion to SIPS surgery. Despite those limitations, this study presents a single surgeon experience with a high follow-up rate at 12, 24, and 36 months. Also, apart from the revision surgery data, the study also had a detailed pre- and postoperative AGB data for 88.8% patients.

Conclusions

The results of this study indicate that laparoscopic 1- or 2-stage revisional SIPS surgery is an effective approach to AGB failure. Care must be taken when removing the lap band ring to avoid leaks. Further studies will be necessary to evaluate the complication rates of all the procedures due to limited numbers.

Disclosures

D.C. reports personal fees and other from Medtronic, outside the submitted work. All other authors have no conflicts of interest to declare.

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