

# Obesity Surgery Results Depending on Technique Performed: Long-Term Outcome

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## Abstract

**Background** Many techniques have excellent results at 2 years of follow-up but some matters regarding their long-term efficacy have arisen. This is why bariatric surgery results must be analyzed in long-term follow-up. The aim of this study was to extend the analysis over 5 years, evaluating weight loss, morbidity, and mortality of the surgical procedures performed.

**Methods** This was a retrospective cohort study of the different procedures for morbid obesity practiced in our Department of Surgery for morbid obesity. The results have been analyzed in terms of weight loss, morbidity improvement, and postoperative morbidity (Bariatric Analysis And Reporting Outcome System).

**Results** One hundred twenty-five patients were operated on open vertical banded gastroplasty (VBG), 150 patients of open biliopancreatic diversion (BPD) of Scopinaro, 100 patients of open modified BPD (common limb 75 cm; alimentary limb 225 cm), and 115 patients of laparoscopic Roux-en-Y gastric bypass (LRYGBP). Mean follow-up was: VBG 12 years, BPD 7 years, and LRYGBP 4 years. An excellent initial weight loss was observed at the end of the second year of follow-up in all techniques, but from this time an important regain of weight was observed in VBG group and a discrete weight regain in LRYGBP group. Only BPD groups kept excellent weight results so far in time. Mortality was: VBG 1.6%, BPD 1.2%, and LRYGBP 0%. Early postoperative complications were: VBG 25%,

BPD 20.4%, and LRYGBP 20%. Late postoperative morbidity was: protein malnutrition 11% in Scopinaro BPD, 3% in Modified BPD group, and no cases reported either in VBG group or LRYGBP group; iron deficiency 20% VBG, 62% Scopinaro BPD, 40% modified BPD, and 30.5% LRYGBP. A 14.5% of VBG group required revision surgery to gastric bypass or to BPD due to 100% weight regain or vomiting. A 3.2% of Scopinaro BPD with severe protein malnutrition required revision surgery to lengthen common limb to 100 cm. A 0.8% of LRYGBP required revision surgery to distal LRYGBP (common limb 75 cm) due to 100% weight regain.

**Conclusions** The most complex bariatric procedures increase the effectiveness but unfortunately they also increase morbidity and mortality. LRYGBP is safe and effective for the treatment of morbid obesity. Modified BPD (75–225 cm) can be considered for the treatment of superobesity (body mass index > 50 kg/m<sup>2</sup>), and restrictive procedures such as VBG should only be performed in well-selected patients due to high rates of failure in long-term follow-up.

**Keywords** Morbid obesity · Bariatric surgery · Biliopancreatic diversion · Laparoscopic gastric bypass · Vertical banded gastroplasty

## Introduction

Currently, there is no doubt about surgical treatment for morbid obesity. Many studies demonstrate high rates of resolution of obesity-related morbidities following weight loss with an increase in life expectancy. Adams et al. [1] analyzed 20,000 morbid obese patients during a mean follow-up of 7.1 years and they observed that adjusted long-term mortality from any cause in the surgery group

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decreased 40%, comparing it to the control group. They observed that cause-specific mortality in the surgery group decreased by 56% for coronary artery disease, 92% for diabetes, and 60% for cancer. Sjöström et al. [2] analyzed 4,000 Swedish morbidly obese patients and found similar results: mortality in the surgery group decreased 50% for coronary artery disease and 30% for cancer. In the management of morbid obesity, the surgical approach has broadly shown its benefits in terms of morbidity and weight loss when compared with medical treatments.

Laparoscopic Roux-en-Y gastric bypass (LRYGBP) has become the most popular bariatric procedure worldwide and it is considered the gold standard for morbid obesity by most of American bariatric surgeons [3, 4]. After a successful operation, long-term follow-up results have evidenced that many superobese patients (body mass index (BMI) > 50 kg/m<sup>2</sup>) have an important weight regain [5]. In contrast, biliopancreatic diversion (BPD) and duodenal switch are both well-known techniques with the best long-lasting results in terms of weight loss and improvement of obesity-related morbidities. However, they can lead to important nutritional and metabolic complications; hence, a severe control of these patients is mandatory.

In the last two decades, many new bariatric procedures and modifications of previous ones have arisen. Bariatric surgery results must be analyzed in long-term follow-up because many techniques that have excellent results in the first 2 years impair the results after this time. In this way, many papers show that vertical banded gastroplasty (VBG) can fail nearly 80% [6] in long-term follow-up.

The aim of this study was to analyze the long-term improvement in obesity-related morbidities and postoperative morbidity after the different bariatric procedures performed in our department.

## Methods

We devised a retrospective cohort study to compare the results of the different surgical techniques for the treatment of morbid obesity performed in the Department of Surgery B of the University Clinic Hospital of Zaragoza (Spain). Five hundred sixty-three morbidly obese patients have been operated on in our Department from July 1976 to December 2007 (Table 1):

- From December 1985 to April 1995, 125 morbidly obese and superobese patients (BMI > 50 kg/m<sup>2</sup>) underwent VBG.
- From April 1995 to June 2001, 150 morbidly obese and superobese patients underwent BPD of Scopinaro (S-BPD: common limb 50 cm; alimentary limb 200 cm).
- Since June 2001, 100 morbidly obese and superobese patients underwent modified BPD (M-BPD: common limb of 75 cm and an alimentary limb of 225 cm).

**Table 1** Experience of department of surgery B of HCU

	No. of cases
Jejunioleal bypass (Scott)	3
Gastrogastrostomy (Lafave and Alden)	3
Vertical banded gastroplasty (Mason)	125
Biliopancreatic diversion (Scopinaro)	150
Biliopancreatic diversion (Larrad)	33
Modified biliopancreatic diversion	100
Laparoscopic Roux-en-Y gastric bypass (Clark and Wittgrove)	115
Revision surgery	34
Total	563

Saragossa (Spain) from July 1976 to January 2008

- Since June 2001, 115 morbidly obese patients underwent LRYGBP (common limb 300 cm, alimentary limb 150 cm; Table 1).

Table 2 shows epidemiological details of the patients and Table 3 illustrates the obesity-related morbidity for the three groups.

The mean follow-up in the VBG group was 12 years (range 5–20 years), 7 years for the BPD group (range 1–13 years), and 4 years for the LGBYRP group (range 1–6 years).

Weight loss, morbidity-related improvement, and postoperative morbidity according to the Bariatric Analysis And Reporting Outcome System (BAROS) classification [7] were studied in all cases.

Follow-up was planned at 1, 3, and 6 months and yearly thereafter. A minimum follow-up of 1 year was required to be included in the study. Patients were contacted by phone when necessary.

For statistical analysis, the *t* Student, Chi-Square, and *U* Mann–Whitney tests were conveniently applied using the Statview program for PC (SAS Institute©).

**Table 2** Preoperative characteristics of the patients

	VBG	S-BPD	M-BPD	LRYGBP
No. patients	125	150	100	115
Obese	60%	40%	30%	98.3%
Superobese	40%	60%	70%	1.7%
Gender				
Male	15%	22%	27%	23%
Female	85%	78%	73%	77%
Mean age (years ± SD)	37 ± 10.4 (16–61)	40 ± 11.2 (18–61)	46.4 ± 8.9 (26–64)	41.3 ± 10.6 (18–63)
BMI (kg/m <sup>2</sup> ± SD)	48.5 ± 7.0 (36.9–70.8)	52.6 ± 8.3 (39–79)	52.7 ± 4.33 (44–61)	44.3 ± 2.8 (36–51)

**Table 3** Obesity-related morbidity

	VBG	BPD	LRYGBP
<b>Major morbidities</b>			
Arterial hypertension	49 (39.2%)	103 (41%)	41 (35.6%)
Diabetes	45 (36%)	43 (26%)	31 (27%)
Cardiovascular disease	8 (6.4%)	21 (17%)	11 (10%)
Respiratory disease	19 (15.2%)	98 (41%)	31 (27.4%)
Hypoventilation–obesity syndrome	16 (12.8%)	56 (14%)	11 (10%)
Sleep apnea syndrome	3 (2.4%)	42 (27%)	20 (17.4%)
<b>Dyslipidemia</b>			
Hypercholesterolemia	38 (30%)	79(34%)	36 (31.3%)
Hypertriglyceridemia	8 (6.4%)	31 (12%)	9 (8%)
Osteoarthritis	37 (29.6%)	54 (27%)	35 (30.4%)
Gynecological disease	11 (8.8%)	19(7%)	7 (6%)
<b>Minor morbidities</b>			
Venous insufficiency of legs	46 (36.8%)	68 (21%)	17 (15%)
Gastroesophageal reflux disease	16 (12.8%)	19 (1,4%)	8 (7%)
Benign cranial hypertension	–	–	1 (0.8%)
<b>Others</b>			
Gallbladder stones	21 (17%)	39 (18.5%)	18 (15.6%)
Abdominal hernia	7 (6%)	37 (18.5%)	5 (4.3%)
Renal colic	–	9(4%)	3 (2.6%)

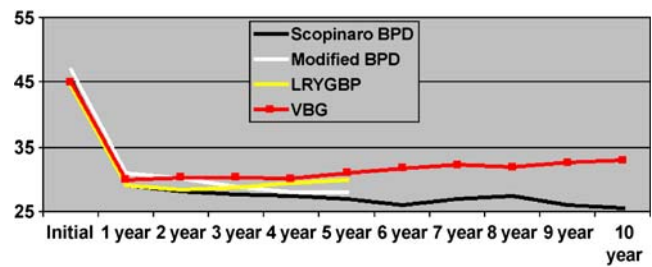
Arterial hypertension: systolic arterial pressure >140 mmHg or diastolic arterial pressure >90 mmHg; diabetes: glycemia >140 mg/dl; hypercholesterolemia: cholesterol >200 mg/dl; hypertriglyceridemia: triglycerides >200 mg/dl

## Results

### Weight Evolution

We analyzed BMI and excess weight loss percentage. A gradual weight loss was observed in all groups during the first 2 years after the operation. After that, weight remains steady with little changes only in the BPD groups (the difference of weight loss between S-BPD group and M-BPD was less than 5% with no statistical significance  $p>0.05$ ). On the other hand, the VBG group showed an important weight regain in the long-term, especially in superobese patients and, finally, the LRYGBP showed a weight regain after 5 years of follow-up (Fig. 1).

If we analyze separately the morbidly obese and superobese patient results, we notice that superobese patients lost weight more rapidly from time zero and gained more rapidly after reaching the lowest weight at the end of the second year than the morbidly obese patients and they get less weight loss than morbidly obese patients. The weight loss from the second year in morbidly obese patients is



**Fig. 1** Weight evolution in obese patients of VBG, BD, and LRYGBP groups. BMI ( $\text{kg}/\text{m}^2$ )

higher in both BPD groups than in LRYGBP and VBG groups (Figs. 1, 2, 3, and 4):

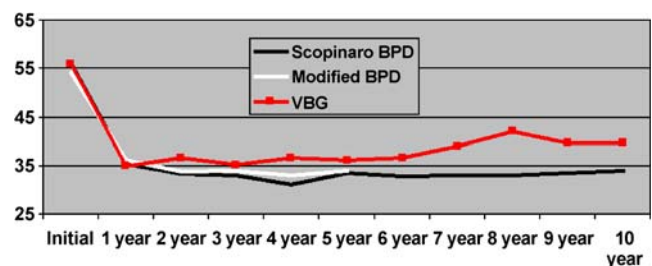
**Obese patients** In the S-BPD group, the BMI after 3, 5, and 10 years was 27.7, 26.9, and 24.9  $\text{kg}/\text{m}^2$ , respectively. In the M-BPD, the BMI at 3 years was 30  $\text{kg}/\text{m}^2$  and at 5 years is 28.5  $\text{kg}/\text{m}^2$ . In the VBG group, BMI at 3, 5, and 10 years was 30.4, 31, and 33.1  $\text{kg}/\text{m}^2$ , respectively. In the LRYGBP, the BMI at 3 years was 28.7 and 30.2  $\text{kg}/\text{m}^2$  after 5 years.

**Superobese patients** In S-BPD group, BMI was 33  $\text{kg}/\text{m}^2$  at 3 years, 32.4  $\text{kg}/\text{m}^2$  at 5 years, and 34  $\text{kg}/\text{m}^2$  at 10 years. In the M-BPD, the BMI at 3 years was 33.6 and 34.3  $\text{kg}/\text{m}^2$  at 5 years. In the VBG group, BMI at 3 years was 35.1  $\text{kg}/\text{m}^2$ ; at 5 years, it was 36.2  $\text{kg}/\text{m}^2$  and at 10 years it was 39.6  $\text{kg}/\text{m}^2$ .

### Postoperative Mortality and Complications

**Postoperative mortality** of VBG was 1.6% (2/125) due to pulmonary thromboembolism and intra-abdominal sepsis. Postoperative mortality of BPD was 1.2% (3/250) due to anastomotic leak, pulmonary thromboembolism, and pneumonia with adult respiratory distress syndrome. No mortality has been recorded in the LRYGBP.

**Early postoperative morbidity** in the VBG group was 25% (30/125), 20.4% (51/250) in the BPD group, and 20% (23/115) in the LRYGBP (Table 4) with no statistical



**Fig. 2** Weight evolution in superobese patients of VBG and BD groups. BMI ( $\text{kg}/\text{m}^2$ )

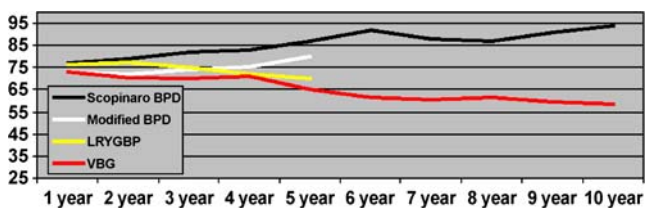


Fig. 3 Weight evolution in obese patients of VBG, BD, and LRYGB groups. Excess weight loss percentage (%)

difference ( $p > 0.05$ ). The commonest complication was wound infection (15% VBG, 10% BD, and 13% LRYGBP). As major complications, we noticed three gastric pouch fistula due to failure of stapler and one gastric pouch necrosis in VBG group (3.2%) and four anastomotic leaks (1.6%) in BPD group and five (4.3%) in LRYGBP group. One patient of VBG group (0.8%) developed hemoperitoneum, two in BPD group (0.8%), and three in LRYGBP group (2.6%).

**Major late complications** Incisional hernia rate in open surgery was 32% for VBG group and 45% in BD (2.6% in LRYGBP). Eleven percent of S-BPD group (16/150) and 3% of M-BPD (3/100) developed protein malnutrition that required hospital stay and parenteral nutrition but there were no cases either in VBG group or LRYGBP group ( $p < 0.05$ ).

**Minor late complications** We found iron deficiency in 20% of patients of VBG group, 30.5% in LRYGBP group, 62% in S-BPD group, and 40% in M-BPD ( $p < 0.05$ ). All patients needed extra-oligoelement incomes to avoid anemia. Of the LRYGBP group, 4.3% (5/115) suffered acute bowel obstruction due to internal hernia that required reoperation (one patient required a massive intestinal resection); complication was not reported either in VBG group or BPD groups. Usual vomits appeared more frequently in VBG group than in BD and LRYGB groups ( $p < 0.05$ ).

Revisional Surgery

Eighteen patients of VBG (14.5%) required conversion to distal gastric bypass (common limb 75 cm) or to M-BPD

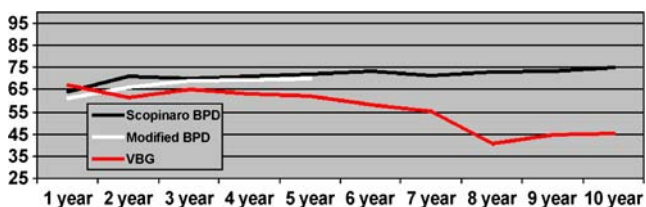


Fig. 4 Weight evolution in superobese patients of VBG and BD groups. Excess weight loss percentage (%)

because of 100% weight regain or frequent vomiting. Eight patients of S-BPD group (3.2%) with severe protein malnutrition required reoperation to lengthen common limb to 100 cm by moving the enteroenterostomy proximally along the biliopancreatic limb. One patient of LRYGBP (0.8%) was converted to distal gastric bypass (common limb 75 cm) because of 100% weight regain.

All these patients keep an adequate weight loss at the moment and no case of malnutrition has been reported.

Beneficial Effects

**VBG group** Hypertension resolved in 65.6% of patients; dyslipidemia resolved in 65% of patients and glycemia became normal in 55.55% of patients. Patients who suffered from sleep apnea syndrome (SAS) and required evening treatment with continuous positive airway pressure (CPAP) were able to interrupt it from first year. These beneficial effects were kept far in time even when weight regain appeared. Only those patients whose weight regain was nearly 80% required medical treatment to control these morbidities.

**BPD groups (Scopinaro and modified BPD)** Glycemia, cholesterolemia, and triglyceridemia became normal in 100% of patients 1 year after operation and were kept stable during all follow-up. Blood pressure decreased too and 82.35% of patients left antihypertensive drugs 1 year after the operation. The rest of these patients decreased the dosage. All patients who had SAS and required CPAP were able to interrupt it after 6 month. Menstruation became regular in 100% of our female patients.

**LRYGBP group** Glycemia became normal in 80% of patients; hypertension resolved in 70% of patients and the rest of the patients decreased antihypertensive dosage. Dyslipidemia resolved in 70% of the patients. All patients who had sleep apnea syndrome in evening treatment with CPAP were able to interrupt it 1 year after operation.

Discussion

We should offer our morbidly obese patients the possibility of weight loss in order to improve their quality of life with as few complications as possible. Moreover, the selected technique has to have lasting weight loss results and it must be tailored to patient characteristics.

Due to the disturbing incidence of protein malnutrition and iron deficiency, we modified the classic S-BPD to avoid those complications in 2001. According to our results, modified BPD gets better results in terms of weight



**Table 4** BAROS postoperative morbidity

	VBG	S-BPD	M-BPD	LRYGBP
<b>Major complications</b>				
Wound dehiscence	–	3 (2%)	–	–
Anastomotic leak	3 (2.4%)	2 (1.3%)	2 (2%)	5 (4.3%)
Hemoperitoneum	1 (0.8%)	1 (0.6%)	2 (2%)	3 (2.6%)
Incisional hernia	40 (32%)	75 (50%)	42 (42%)	3 (2.6%)
GI bleeding due to ulcer	1 (0.8%)	1 (0.6%)	–	1 (0.8%)
Protein malnutrition	–	16 (11%)	3 (3%)	–
Pneumonia	4 (3.2%)	1 (0.6%)	1 (1%)	–
Pulmonary thromboembolism	3 (2.4%)	1 (0.4%)	–	–
<b>Minor complications</b>				
Wound infection	19 (15%)	14 (9%)	7 (5%)	15 (13%)
Anastomotic edema–stenosis	11 (9%)	9 (6%)	4 (4%)	7 (6%)
Usual vomits	42 (34%)	9 (6%)	2 (2%)	17 (15%)
Stomal ulcer	1 (0.8%)	8 (5%)	–	3 (2.6%)
Deep vein thrombosis	–	2(1.3%)	–	–
Iron deficiency	25 (20%)	93 (62%)	40 (40%)	35 (30.5%)
Hypoalbuminemia	–	24 (16%)	7 (7%)	–

loss than gastric bypass and than VBG in morbidly obese patients.

LRYGBP can fail in 35% of superobese patients with at least 10 years of follow-up as it is reported in literature [8]. In our series of superobese patients, the M-BPD kept the weight loss after second year as it happens in S-BPD series but with less complications.

When the complexity of surgery increases, morbidity as well as mortality can rise too. Mortality reported for LRYGBP is nearly 1% but can rise to 2% in some papers [9, 10]. Mortality for VBG can reach 3% [11] and 3% for BPD [12].

In our series, global early postoperative morbidity according to BAROS classification was higher in VBG group (25%) than in BPD (20.4%) and LRYGBP groups (20%), but the different complications were more severe in these last groups. The most important complication of BPD is protein malnutrition characterized by edema, alopecia, asthenia, anemia, and hypoalbuminemia that can reach from 3% to 11% of the patients. Out of them, 6% are severe cases, in which a reoperation to restore or remake the intestinal circuit could be the only solution [13]. In our series, the mean of malnutrition was 11% for S-BPD group and 3% for M-BPD, and 3.2% of the patients of S-BPD required revisional surgery (no cases of revisional surgery were reported in M-BPD group). Some bariatric groups also modified Scopinaro original technique to lengthen common limb or practice a duodenal switch (common limb 65 cm) to decrease protein malnutrition rate, as we did in 2001 [14].

Iron depletion is also a notable complication after surgical procedures that carried out a gastrectomy with duodenal and proximal jejunum exclusion. This deficiency

can be found in nearly 52% [14] of BPD patients and can lead to anemia in fertile women patients or in case of anastomotic ulcer (62% in our series of S-BPD after a period of 12 years of maximum follow-up and 40% in M-BPD). Although iron deficiency reported in restrictive procedures can be 10% [15], in our series, it rises to 20% due to low intake because of vomiting. After LRYGBP, iron deficiency reported is near 30% but can be up to 53% [16] (30.5% in our series). Iron supplements have been recommended prophylactically to all patients as multivitamin complex pills. Iron oral intake was reserved only for patients with low iron or ferritin levels in blood serum.

Incisional hernia is the commonest surgical complication after any open abdominal surgery, but in obesity surgery the weight loss eases it. Laparoscopic approach can decrease incisional hernia rate to 10% (2.5% in our laparoscopic group). After weight loss stabilization, normally at 18–24 months, we recommend an abdominal dermoliplectomy (it has been proven necessary in most of our female patients) and the abdominal wall is repaired at this time. When slimming leads to social problems and psychological diseases, global body contouring must be done by plastic surgeons. According to our results, it seems that our series shows a higher (50%) rate of incisional hernia than previously published (39%) [17]. This could be explained because we have included asymptomatic cases in which incisional hernia is detected when dermoliplectomy is performed. There were no cases of hernia strangulation.

The effect caused by weight loss in glycemia and lipid plasma levels is well known, which become normal between the first and third months after biliopancreatic diversion, yet with overweight [18] or even when weight

regain appears [19]. In our series, all the patients of our BPD groups could leave their preoperative treatment during the first year. Some authors defend a technique-dependant effect in the BPD to explain the high rates (100%) of healing that this technique provides. It seems to be related to a change in the enterohepatic circulation of bile salts that can increase the production of biliary acids decreasing the cholesterol pool. In these patients, the fecal excretion of bile acids can be as high as 750 mg/day (normal values of bile acids in stools are 400 mg/day) [20]. In the rest of the bariatric procedures, this technique-dependant effect does not exist and the lower rate of resolution of dyslipidemia can be explained by the weight reduction. In our series, only 70% of the LRYGBP group and 65% of the VBG group could leave treatment to control cholesterol and triglycerides levels.

The ideal length of common limb remains unclear and malabsorptive procedures have modified the limb length to control nutrient absorption [21]. Since BPD was described in 1979, it has been modified to keep weight loss and to decrease postoperative morbidity rates. Some authors maintain that common limb must not exceed 100 cm long to get an adequate weight loss [22, 23].

LRYGBP has long been associated with the possible development of internal hernias. Paroz et al. [24] reports an incidence of 1–5%, 4.3% in our series (one patient required a massive bowel resection). The laparoscopic approach seems to increase the rate of this complication, which can present dramatically, when weight loss reduces intra-abdominal fat, because it induces fewer adhesions than laparotomy and the closure of the mesenteric defects is more difficult than in open surgery.

Some bariatric techniques that failed years ago, like purely restrictive ones (open gastric banding), are now performed by laparoscopy. The laparoscopic approach, with quick recovery and less morbidity than open surgery, can tempt some surgeons to carry out restrictive procedures because they are easier techniques with “less” aggression and complications than LRYGBP and BPD [4]. Their long-term results show high rate of failure with a mean of excess weight loss percentage less than 50% [25] as it happened with the open gastric banding years ago. That is why we must avoid old mistakes and we must keep in mind the experience of the international bariatric groups that demonstrated years ago the limits of some open restrictive procedures.

Although 10-year results would be more meaningful, we can offer results classified as mid- and long-term results by the committee of standards of the American Society for Bariatric Surgery [26]. The publication of preliminary results about bariatric surgery can be dangerous because there are techniques like restrictive procedures that have shown excellent preliminary results [27, 28], but their long-

term results are inadequate [29, 30]. According to our results of weight loss and morbidity, M-BPD gets better results in terms of weight loss than in both gastric bypass and VBG in morbidly obese patients. Owing to the metabolic complications of BPD, we think that LRYGBP is a good technique for morbid obesity and M-BPD should be considered as an adequate technique in patients with morbid superobesity, where LRYGBP can fail in long-term follow-up [5, 8] because it keeps a good weight loss and it has less morbidity than S-BPD.

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