Diverted MGB: A New Procedure

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30.1 Introduction

Since the introduction by Mason and Ito in 1966 [1] of the loop gastric bypass, subsequently modified to the Roux-en-Y gastric bypass (RYGB), this procedure has proved for years as the most consistently successful treatment for the greatest number of patients. RYGB is also the most well researched bariatric operation, with >7780 peer-reviewed publications in 2013 [2]. RYGB has been, for many years, the most effective and well balanced metabolic/bariatric surgical technique, with >50% excess weight loss (%EWL) maintained beyond 10 years [3].

Yet, RYGB patients may contend with significant complications, such as internal hernias, marginal ulcers or hyperinsulinemic hypoglycemias. Intermediate-term weight regain is also a very serious concern. Christou et al. demonstrated that both morbidly obese and super-obese RYGB patients experienced significant weight regain from the nadir to 5 years and again from 5 to 10 years [4]. Some researchers report that weight regain following RYGB may be as high as 50% of weight lost [5].

Weight regain contributes to the overall failure rate of a particular bariatric procedure, as defined by the percentage of patients that do not achieve or maintain 50% EWL at follow-up [6]. Yet, the long-term failure rate for RYGB has been calculated at ~20% [4, 7]. This rate can be as high as 40–60% for super-obese patients undergoing RYGB [8].

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30.2 Rationale of the dMGB

From 2002 up to 2010, RYGB had been our main operation for obese patients, and we were able to see failures in about 10% of our patients—the ones who completed a follow-up >5 years. In 2% of additional cases, clinically significant complaints of hyperinsulinemic hypoglycemia presented. Such events pushed us to find a better solution, with less weight regain and hypoglycemia.

With experience and personal support by Miguel Angel Carbajo and Manoel Garcia Caballero, plus Wei-Jei Lee prospective data [9], we began another technique to provide better long-term weight loss and much less hypoglycemic complaints. With technical instruction from Robert Rutledge in our operating-room, we became MGB-OAGB practitioners for about 60% of our operations. We found it a simpler safe technique with a better clinical course and weight loss in the vast majority of the primary patients.

However, like Noun [10], we were still facing a high rate of revisional surgery for failure or complications from the thousands of gastric bands used before in our country. In our global series, one-third of the cases were failed gastric bands, and we embraced the MGB-OAGB as a salvage technique, where the anastomosis was far from the after-effects of the band presence (inflammation, scar and devascularization).

We tried the OAGB and MGB variants, and decided to standardize an intermediate technique incorporating steps from both, the one we are performing as a main part of the *diverted MGB*, which we will describe later. The only significant clinical issue when we evaluated the first 200 cases of OAGB-MGB, was a rate of 4% of non-acid reflux, which we had to revise.

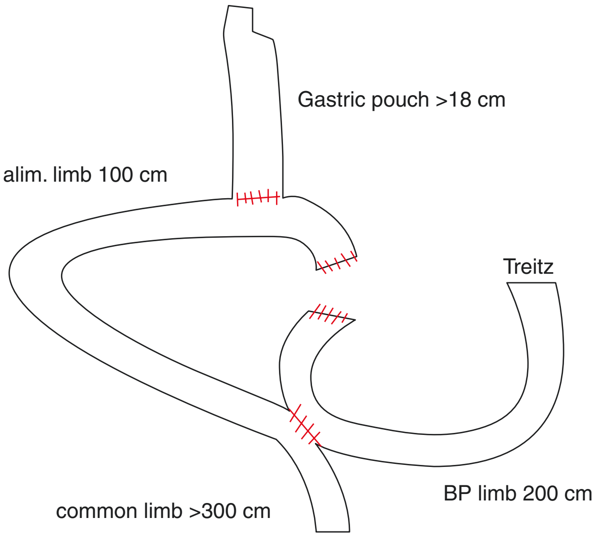
There is still a controversy about the incidence and importance of so-called “biliary reflux” after OAGB-MGB [11, 12]. This kind of gastro-esophageal reflux (GER), many times with an acid component which allows a good response to proton pump inhibitors (PPI), could be more properly designed as “enterobiliar and acid reflux” (EBAR).

The OAGB has surgical steps to avoid GER, the so-called anti-reflux mechanism, and very low rates (2%) of biliary reflux are reported after the OAGB [13]. However, the pure MGB surgeons using a long pouch from below crow’s foot, report approximately 1% of biliary reflux [14]. Musella, presented experiences with higher rates, mainly after revisions for failed gastric bands [15].

In our patients who had a severe non-acid reflux, we revised them and added a Roux-en-Y diversion to the previous MGB, using the “simplified gastric bypass” or “double loop” technique [16] that we had used before in the classic RYGB. In this technique, we measure 100 cm in the efferent limb, from proximal to distal, and we move that place enough to be in parallel with the afferent loop, immediately before the gastro-ileostomy. In other words, we create a new side-to-side ileo-ileostomy and we apply one endostapler cutting between the two anastomoses (Fig. 30.1). We perform a hernia repair (cruroplasty) whenever it is present and bigger than 2 cm.

These patients obtain a very good clinical condition, solving completely the reflux episodes and keeping their weight low as before. Therefore, we decided to perform this technique in obese patients prone to significant reflux in the future,

Fig. 30.1 Schematic diagram of diverted mini-gastric bypass (dMGB)



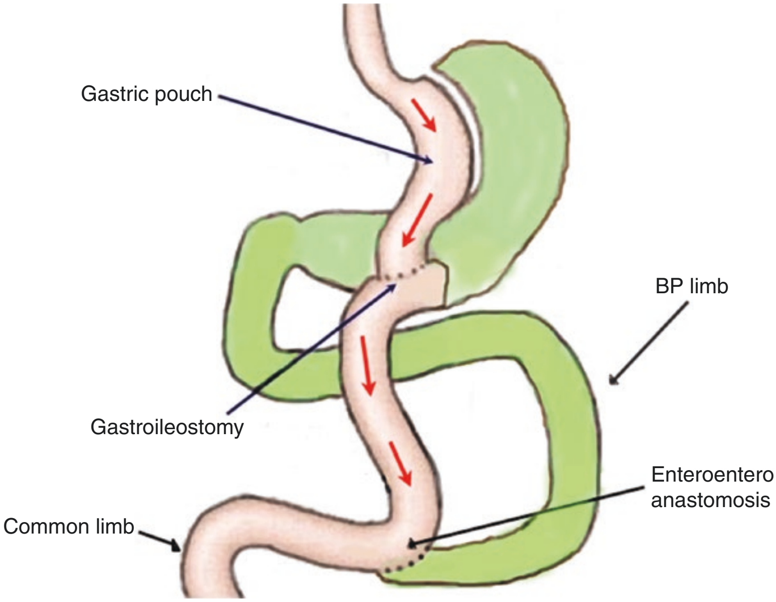


Fig. 30.2 Food flow in dMGB

typically the patients after removing a gastric band or in presence of a big hiatus hernia. Then, we standardized this procedure and called it "*sleeved gastric bypass*" because of the long and thin pouch, resembling the "sleeve gastrectomy" (Fig. 30.2) in the upper GI series that we perform routinely 1 year after the operation (Fig. 30.3). After a suggestion from Mervyn Deitel, we changed the name to *diverted MGB*—"dMGB", which is the technique we will describe in this chapter.

Fig. 30.3 Gastric pouch and gastro-ileostomy at upper GI series

This concept involves the "OAGB-MGB" with the Roux-en-Y diversion on the top of a long pouch with a non-calibrated anastomosis. People often get confused and understand this technical drawing as a RYGB, but it is closer to the OAGB-MGB concept because it has a long and narrow pouch and a wide anastomosis, resulting in mild restriction. Also, the biliopancreatic limb is long (usually 200 cm or more), providing some fat malabsorption that, in contrast to the RYGB, lasts for the future.

In all the aspects, except in the reduction of the daily bowel movements, we found dMGB similar to MGB-OAGB regarding morbi-mortality, post-operative course, weight loss and metabolic control. The only concern is about the inter-mesenteric spaces which need to be closed (unlike in OAGB-MGB), to avoid complications from bowel obstruction due to internal hernias.

30.3 Surgical Management

30.3.1 Pre-operative Course

All the primary patients were pre-operatively submitted to a complete multidisciplinary approach with endocrinological, psychological, nutritional and psychiatric evaluation. This was also done in the revisional cases, and in these, we consider it mandatory to include an endoscopic and imaging assessment before the reoperation.

In the pre-operative management, all the patients were given a hypocaloric pre-operative diet (1000 Kcal/day) for a minimum of 7 days). The significant co-morbidities like anemia, diabetes, hypothyroidism, sleep apnea or nutritional deficits received specialized treatment and support, especially anemia or hypoproteinemia. The patients also received some prophylactic treatments like assisted respiratory kinestherapy with incentive spirometry, and vitamin and mineral supplementation. Women are counseled to stop contraceptive pills. All patients on anticoagulant drugs or anti-aggregant agents stopped them accordingly to our protocol. Included in the pre-operative protocol are prophylactic antibiotherapy (cefazoline) and the thromboembolism prevention (subcutaneous enoxaparin and intraoperative intermittent pneumatic compression).

30.3.2 Surgical Technique

In our operating set up, we use the French position (Fig. 30.4) with a 30° reverse Trendelenburg tilt, the surgeon between the legs. We use two monitors, one on each side of the patient's head (Fig. 30.5).

For pneumoperitoneum, we use the closed method with a Veress needle introduced in the Palmer point. The first trocar (10–12 mm) is introduced in the midline, usually in the division between the upper two-thirds and the inferior third of the xipho-umbilical line. The other two 12-mm trocars are positioned beside the first one, at a slightly superior level, with a minimum of 8 cm distance to avoid instrumental clashing and obtain a nice triangulation. Another 5-mm left subcostal trocar, 6 cm from the left 12-mm, is introduced and used by one assistant to support the surgeon right-hand maneuvers. A Nathanson liver retractor is introduced (no trocar needed) in the subxiphoid space, supported by a left side positioned Murdoch arm (Fig. 30.6).

The instruments used consists of a 30° optical lens, 3 fenestrated graspers (one of them long), 1 dissector, 1 hook, 1 scissors, 1 needle-holder, and 1 Babcock (12 mm).

Fig. 30.4 Lithotomy position

Fig. 30.5 Team position

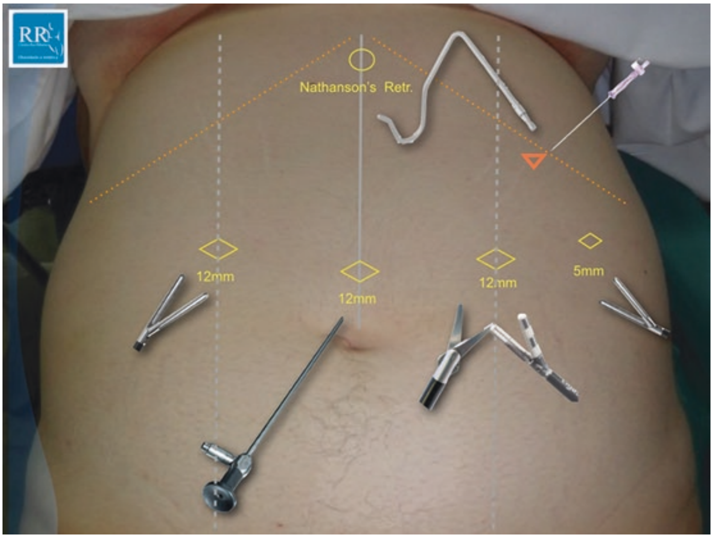


Fig. 30.6 Ports and instruments distribution and usage

After an abdominal exploration, the bowel is evaluated to check that it is free enough to perform the bypass.

We begin the procedure by dissecting partially the phrenogastric ligament in the area of the last short gastric vessels. In the case of a hiatus hernia (unsuspected or previously known), we go through the pars flaccida and dissect the right crus to evaluate the hiatus and perform an esophageal dissection and cruroplasty, if a hernia is bigger than 2 cm.

Then, we go to the incisura angularis and cut the two inferior vessels (Fig. 30.7) with a sealing device (Ligasure® 5-mm or Ultracision®, sometimes using only the hook) and get access to the retrogastric space. We build a long gastric pouch with an endostapler (Endogia™ Tristaple™) over a 36- French boogie (Fig. 30.8).

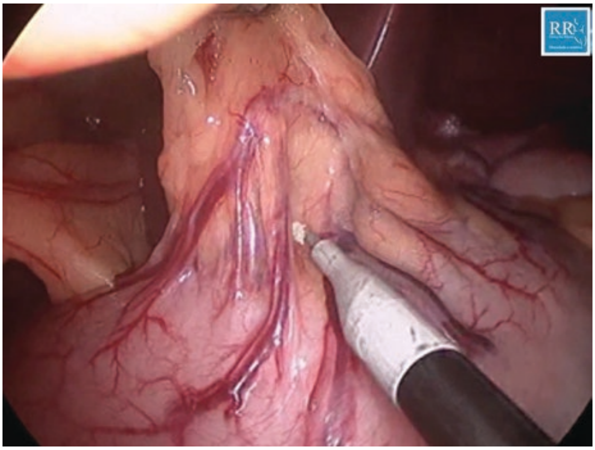


Fig. 30.7 Incisura angularis approach

Fig. 30.8 Pouch construction

According to the gastric wall thickness, we choose the staple height, Tristaple™ 45-mm, purple or black in the first application, purple or tan in the following ones up to the top. The boogie is inserted after the second stapling moment. It is important to fire the cartridges, keeping the pouch in a straight and stretched position to avoid torsions. Pushing the pouch tip with the boogie and maintaining the gastric walls' symmetry with a grasper is essential. Dissection of retrogastric adhesions of the stomach to the pancreas is done.

If some bleeding spots appear in the staple-line, we control them by touching the stapled oozing point with the electrocautery (using the hook or the dissector) in a very brief and localized manner.

Retracting the omentum upwards, we find the angle of Treitz and begin to run and measure the bowel distally up to the place where we want to perform the gastro-enteric anastomosis. A very important detail during measurement is to keep the bowel loop with distal bowel in the patient's right side and the proximal in the left one; otherwise, we take the risk of a future torsion of the anastomosis we intend to perform. The omentum does not have to be cut, because the anastomotic level is low enough to avoid any tension on the bowel.

The proximal bowel segment will be the biliopancreatic limb (BP limb). Usually 200 cm long, we tailor this length making it longer (250 or 300 cm) in the case of diabetic or super-obese patients, or even more with BMI >60 kg/m^2. It will be shorter (180 or 150 cm) in patients with BMI <40 or 35 kg/m^2, or in patients >60 years old. Afterward, we try to measure all remaining bowel. In the case of short mesenteries or heavy intestine, this may be dangerous because some tearing or even perforation may occur. If this is the case, it is enough to count on, at least, 4 m of bowel down, which means 1 m for the future alimentary limb and 3 m for the future common limb. If this is not possible, the BP limb length will be decreased as much as needed to accomplish this rule.

At the selected point to construct the anastomosis, we make an antimesenteric hole, using the hook, in the bowel and another in the anterior face of the inferior top of the pouch. We introduce an articulated 30-mm Tristaple™ cartridge into the bowel and the fixed anvil into the stomach (Fig. 30.9), as close as possible to the gastric staple-line. The device is fired and the anastomosis is done; we check the inner surface of the new stape-line for bleeding and push the bougie to the distal bowel. The resulting hole is closed in a hand suture manner in a running invaginating technique, using a 2/0 Vicryl® or similar (Fig. 30.10).

Pulling the bougie tip back to the stomach and clamping the bowel on both sides of the gastro-enterostomy, we introduce diluted methylene blue through the bougie to exclude any leaks. A silk single stitch in the corner between the pouch staple-line and the bowel is done ("neo angle of sorrow"), as this is a site prone to leaks, because of some eventual localized tension on the anastomotic staple-line.

Measuring the bowel distally, we make another hole 1 meter far from the gastro-enterostomy. We do the same in the afferent limb (Fig. 30.11), 10 cm before the gastro-enterostomy and, using the previously described technique (Fig. 30.12), we create another side-to-side anastomosis (ileo-ileostomy), with an articulated 60 mm Tristaple™ cartridge. The hole is closed as before, and the Roux-en-Y diversion is matured by cutting the bowel between the two

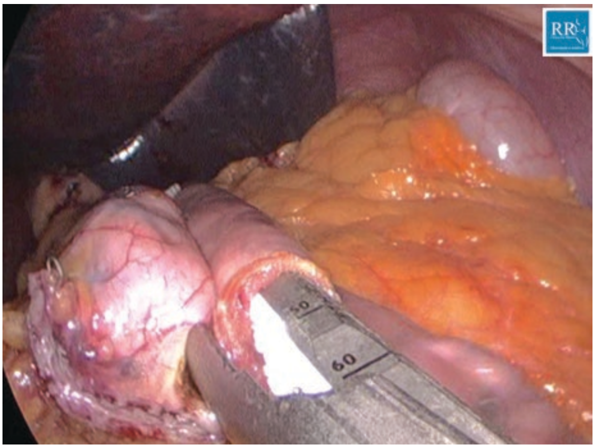


Fig. 30.9 Linear mechanical gastro-ileostomy (G-I)

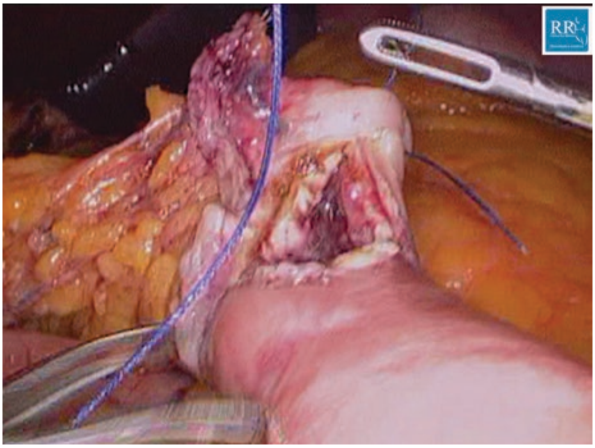


Fig. 30.10 Manual suture closing the G-I hole

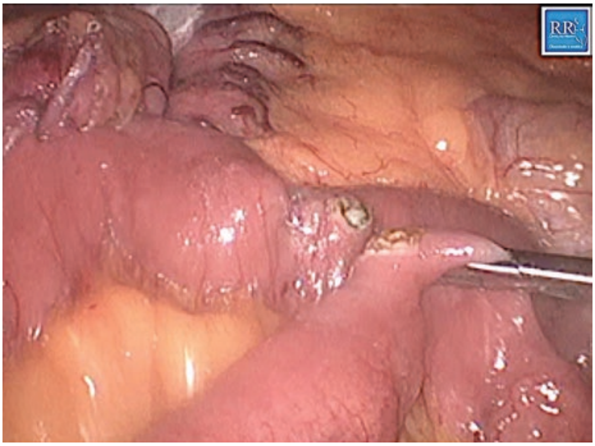


Fig. 30.11 Bowel openings for ileo-ileostomy (I-I)

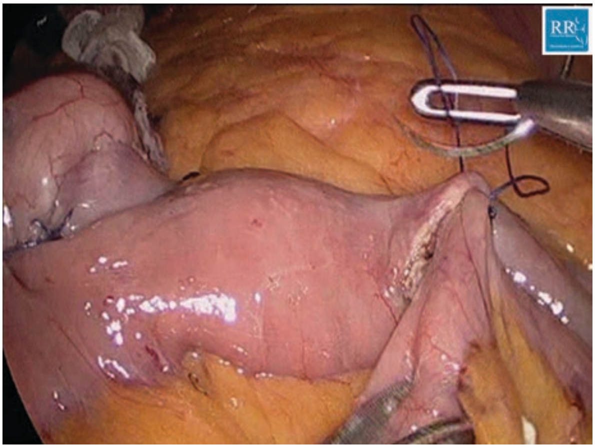


Fig. 30.12 Manual suture closing the I-I hole

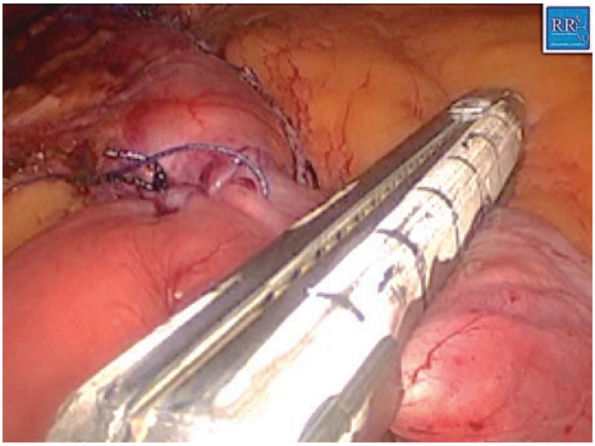


Fig. 30.13 Roux-en-Y maturation

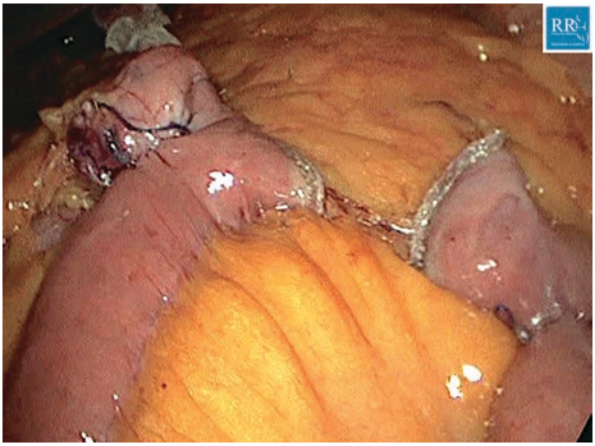


Fig. 30.14 Alimentary limb (left side) and BP and common limb (right side)

anastomoses using another 60-mm Tristaple™ cartridge (Fig. 30.13), and defining the alimentary limb on the left and the BP and common limb on the right of the image (Fig. 30.14).

For closing both the intermesenteric and the Petersen space, we use purse-string sutures with 2/0 silk or barbed non-absorbable sutures. The last step consists in the application of a spray of fibrin glue (Tisseel® 4 cc) on the staple-lines and anastomosis. We suture the aponeurosis of ports created by larger than 11-mm trocars.

We use drains selectively accordingly to a number of possible bleeding spots and the quality of the tissues and anastomosis. The boogie is removed and no nasogastric tube or urinary catheter is left.

30.3.3 Post-operative Course

The patients should leave the bed the same day of the surgery, and we introduce liquids in small portions (20 cc each 20 min) 12 h after the end of the operation. We administrate a proton pump inhibitor drug (PPI), an antibiotic, an analgesic, and enoxaparin. The patient is usually discharged on the second post-operative day. He/she will continue the PPI 6 months in women and 12 months in men and the enoxaparin for 7 days. Ursodeoxycholic acid will be administered twice a day for 3 months. Oral multivitamin and vitamin D are administrated to all patients and iron, vitamin A, B_9 or B_{12} when the lab-tests show deficits in those elements.

The protocol includes visits to the team every 3 months in the first year, every 6 months in the second, and then one time each year. Once a year, we check for *Helicobacter pylori* (and eradicate it if positive) and ask for an ultrasound to detect biliary stones. Usually, we perform an upper GI series at the end of the first post-operative year and an endoscopy if the patient has complaints suggesting esophago-gastric pathology.

30.4 Outcomes

The dMGB was introduced in our practice in 2013 as a primary approach to patients with risk factors for development of esophageal reflux, whether acid or non-acid. As a rescue surgery for failed gastric bands or sleeve gastrectomies, it became a safe and effective procedure.

We analyzed the outcomes of our first 300 dMGB operations, with follow-up from 6 to 48 months. This experience included 131 revisional cases (104 conversions from failed bands – 35 previously removed, and 27 failed sleevel gastrectomies).

The average age was 45.8 years (range 16–70), and the average BMI was 41.3 (range 27.8–56.9). Associated operations were 69 band removals, 73 hiatoplasties, 20 cholecystectomies, and 8 other procedures.

All the operations were completed by laparoscopy with no conversions. The mean operating time was 65 minutes (range 45–195).

The weight loss of the 300 patients went from a pre-operative mean weight of 111.2 kg (BMI 41.3) to 76.9 kg (BMI 29.6) in the patients who had 4 years of follow-up. The % excess BMI loss (%EBMIL) was 81.6% at 1 year, 81.0% at 2 years, 80.2% at 3 years and 76.8% at 4 years follow-up (Fig. 30.15).

When we differentiated between the primary (169) and revisional (131) cases, we found a difference in favor of the primary cases who had %EBMIL of 87.0% at 1 year (74.3% in revisional), 88.5% at 2 years (71.3% in revisional), 88.7% at 3 years (68.6% in revisional), and 82.9% at 4 years (68.8% in revisional) (Fig. 30.16). Statistical analysis of the %EBMIL of primary and revisional cases (Student t-test) found significance $p < 0.05$ at 1, 2 and 3 years post-operatively. Another important observation was that only three patients (1%) had some weight regain and none had excessive weight loss.

Co-morbidities showed resolution in the associated diseases, especially type 2 diabetes (80.2%), high blood pressure (70%), dyslipidemia (54%), hyperuricemia (60%), degenerative joint disease (55%), and obstructive sleep apnea—OSA (67%). Importantly, 54% of diabetics, 44% of high blood pressure, 42% of dyslipidemias and 49% of joint disease patients were off medications. OSA patients were free of treatment in 63% (Table 30.1).

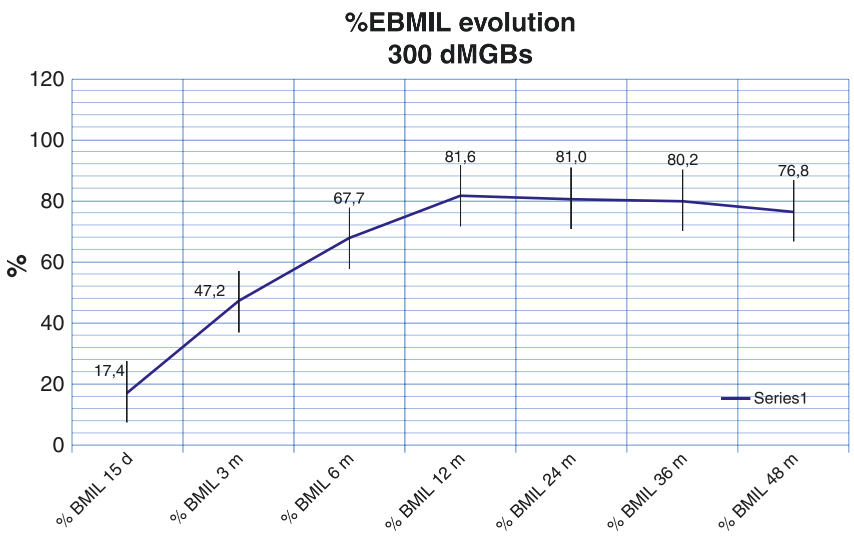


Fig. 30.15 % excess BMI loss (%EBMIL) after 48 months

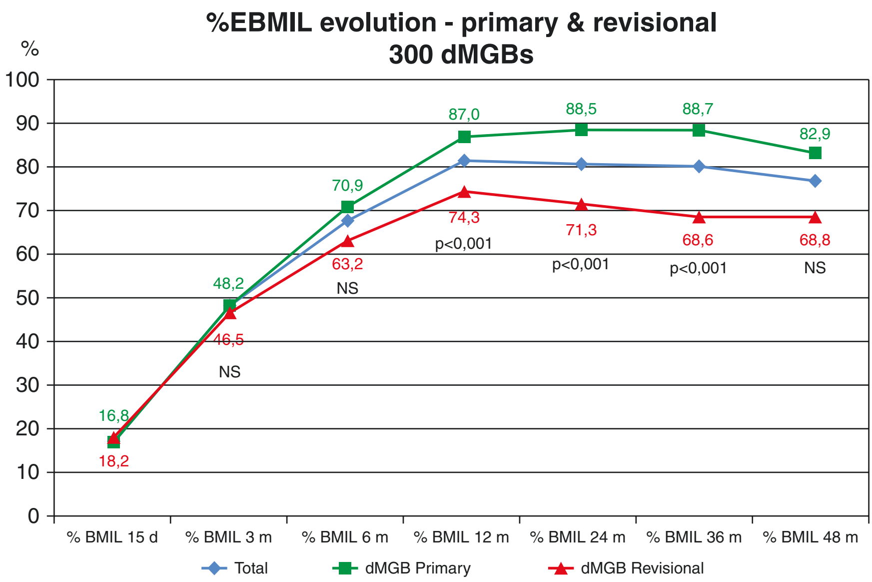


Fig. 30.16 %EBMIL in primay and revisional cases after 48 months

Although there may be some bias in the selection criteria for dMGB (all cases were prone to have GE reflux symptoms), 41.7% had clinical evidence of GERD. Of these, 63% were free of symptoms after dMGB, 4% improved, 2% became clinically stable and only two patients (0.7%) got worse GERD. No *de novo* cases were found.

Table 30.1 Resolution of co-morbidities after dMGB

	T2D (%)	HBP (%)	Dyslip (%)	URICEMIA (%)	DJD (%)	OSA (%)	GER (%)	Depression (%)	Varices (%)
Remission – No medication	54	44	42	27	49	63	63	20	5
Improved – With medication	26	26	12	33	6	4	4	14	2
Stable	2	1	2	–	3		2	8	32
Worse	–	–	–	–	–	–	1	–	–
New disease	–	–	3	7	–	–	–	3	–

T2D type 2 diabetes, *HBP* high blood pressure, *Dyslip* dyslipidemia, *DJD* degenerative joint disease, *OSA* obstructive sleep apnea, *GER* gastro-esophageal reflux

In our database, we have 2.6% of *de novo* GERD symptoms after MGB-OAGB in an evaluation of 650 patients. dMGB performed better avoiding *de novo* GERD.

30.5 Complications

Our series includes 131 (46%) cases of conversion: from 69 patients with a gastric band (23%), from 35 patients who had a prior band (12%), and from 27 with sleeve gastrectomy (9%). Complications in laparoscopic bariatric surgery are more frequent in revisional surgery [17, 18]. The adhesions, the scars and modifications of the normal vascularization of the tissues are main factors for an increase in complications [19]. Good outcomes and acceptable risk may be accomplished [19, 20], depending on the pre-operative study to define the risk of any proposed revisional intervention [20] and on the experience of the surgical team. A conversion to open surgery is more likely due to the increased difficulties that a surgeon faces in revisional surgery [21]. In our series, we had no conversions to open surgery.

We had 6 intra-operative complications (2%): bowel loop perforations (2), bowel ischemia (2), gastro-enterostomy torsion (1) and hepatic contusion (1).

Post-operative complications occurred in 30 patients (9.9%), 17 (5.6%) early and 13 (4.3%) late. We performed 17 reoperations (5.6%) in this group – 10 (3.3%) in the early period and 7 (2.3%) >30 days after the initial operation (Table 30.2). There was no mortality.

Table 30.2 Post-operative complications after dMGB

Post-operative complications		
Early	*"n"*	*Reoperations*
Hemoperitoneum	2	2
Intra-abdominal infection	2	2
Pouch leak (His angle)	1	1
Ileo-ileal anastomotic leak	1	1
Bowel perforation	1	1
Wound infection	3	–
Abdominal wall hematoma	2	1
Port-site hernia	3	2
Hematochezia	1	–
Pleural effusion	1	–
Sum	17 (5.6%)	10 (3.3%)
Late	*"n"*	*Reoperations*
Alimentary intolerance	3	2
GERD	3	2
Marginal ulcer	3	1
Steatorrhea	1	–
Port-site hernia	1	–
Cholelithiasis	2	2
Sum	13 (4.3%)	7 (2.3%)
Total morbidity	30 (9.9%)	17 (5.6%)

Conclusion

MGB-OAGB provides better outcomes and fewer complications compared to RYGB. It solved the two problems we have had with the RYGB – weight regain and hyperinsulinemic hypoglycemia. However, biliary or non-acid reflux can occur, although with a low incidence.

However, the dMGB appears to be as effective as the MGB and reduces the incidence of GER. It avoids bile in the esophagus and its potential consequences. dMGB combines the advantages of the MGB-OAGB (mild restriction and moderate malabsorption) with the anti-reflux effect of the Roux-en-Y diversion. The dMGB is also a convenient and effective solution for failed sleeve gastrectomy from weight regain or GERD. Also, from a technical point of view, MGB-OAGB or RYGB surgeons can reproduce the dMGB easily and safely.

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