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CLINICAL RESEARCH

# Revision to Malabsorptive Roux-En-Y Gastric Bypass (MRNYGBP) Provides Long-Term (10 Years) Durable Weight Loss in Patients with Failed Anatomically Intact Gastric Restrictive Operations

## Long-Term Effectiveness of a Malabsorptive Roux-En-Y Gastric Bypass in Salvaging Patients with Poor Weight Loss or Complications Following Gastroplasty and Adjustable Gastric Bands

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**Abstract**
*Background* Twenty percent of gastric restrictive operations require revision. Conversion to Proximal Roux-en-Y gastric bypass (PRNYGBP) is associated with weight regain. Forty-one percent of these fail to achieve a body mass index (BMI)<35. Few report follow-up (F/U) or quality of life (QOL) beyond 5 years. We report the long-term effectiveness of MRNYGBP as a revision.
*Methods* Retrospective chart review of patients (1993–2005) with a failed gastric restrictive operation (S1) at least a year out from revision (S2) to a MRNYGBP: small lesser curve 22±10 (11–55) $cm^3$ pouch, long biliopancreatic limb, 150 cm alimentary limb, 141±24 (102–190) cm common channel. Staple-line disruptions were excluded.
*Results* Thirty-eight (37 F, 1 M) patients aged 46±8 (17–56) years underwent conversion to a MRYGBP 8±5 (2–23) years after: gastroplasty 25, adjustable gastric band 13 for weight regain (79%), gastroesophageal reflux disease (GERD; 29%), and band problems (24%). S1 provided only 24±25% excess weight loss (EWL; 5.9±6.3 BMI drop) and caused GERD in 32% of patients ($p$=0.0124). There were no deaths or leaks. BMI dropped from 41.4±7.8 to 27.3±5.6 (down 20.5±8.3 from S1), 80.1±23.3% EWL ($n$=32) at year 1 ($p$<0.0001). This was maintained for 10 years. BMI was 28±4 (21.5–31.9), 75.6±21.1% EWL (57.3–109.6) ($n$=5) at 10 years. Super obese patients had better 9.95% EWL after S2 ($p$=0.0359). QOL (5=excellent): 4.5±0.5 (3–5). F/U: 5.1±3.3 (1–13) years with 83.3% F/U 10-year rate. Labs at 3 years ($n$=10): Alb 3.8±0.4, Prot 6.8±0.6, Iron 47.6±33.3, VitD 15.1±7.43, PTH 54.5±27.2, B12 620.1±676.5, Hct 34±4.3.
*Conclusions* Revision MRNYGBP provides excellent durable long-term weight loss after failed gastric restrictive operations. Non-compliant patients are at a higher risk for malnutrition, anemia, and osteoporosis.

**Keywords** Revision · Gastric bypass · Adjustable gastric band · Gastroplasty · Malabsorption · Medial gastric bypass · Roux-en-Y gastric bypass · Distal gastric bypass · Malabsorptive Roux-en-Y gastric bypass · Revision gastric bypass · Bariatric surgery · Failed bariatric surgery · Poor weight loss · Poor weight loss after gastric banding · Weight gain

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## Introduction

Gastric restrictive operations such as the vertical banded gastroplasty (VBG), the vertical ring gastroplasty (VRG),

and the adjustable silastic gastric band (ASGB) were popular in the aftermath of the condemnation of pure malabsorptive surgeries such as the jejuno-ileal bypass. It is predicated that laparoscopic adjustable gastric band (AGB) will surpass proximal Roux-en-Y gastric pypass (PRNYGBP) as the most commonly performed weight-loss surgery in the USA.

Twenty percent of gastric restrictive operations have eventually required revision to gastric bypass [1, 2]. Most of these were converted to PRYNGBP with 17–26% morbidity rates [3–5]. This operation fails to restore body mass index (BMI)<35 in 41% of patients at 1 year and BMI<30 in 64% at 10 years, thus leaving them with clinically severe obesity and its associated hazardous comorbidities [4, 6]. Few studies report follow-up (F/U) beyond 5 years (Table 1) [4, 7]. Its long-term efficacy as a primary operation in the super obese has not been ratified [6]. Long-term outcome after conversion to gastric sleeve [8], resectional gastric bypass [9], or biliopancreatic diversion [10] is unknown and not always successful [11]. The ideal operation to control recurrent obesity in patients with conventional anatomically intact gastric restrictive operations, who are true "non-responders" has not yet been defined. One would hope that a revision we have to offer this enlarging pool of patients should have a better predictable weight-loss outcome to warrant the higher risk we are subjecting them to.

We reported our 3 years, 89% excess weight loss (EWL) after primary Distal RNYGBP (DRNYGBP) [12] and as a revision [13]. We performed 1,700 MRNYGBP between 1993–2006. Its durable weight-loss outcome prompted us to convert failed gastric restrictive operations to MRNYGBP. We report this experience.

## Methods

Retrospective chart review of patients (1993–2005) with a failed gastric restrictive operation (S1) at least a year out from revision to a MRNYGBP (S2). Only those with an anatomically intact restriction −VBG, VRG, ASGB, AGB were included to ensure reproducibility of weight-loss calculations and establish efficacy of the revision. Revisions for staple-line disruption (SLD), band erosion, any anatomy that precluded conversion to or did not conform to a standard MRNYGBP and non-primary revisions were excluded. Patients were asked to rate their current overall quality of life (QOL) on a simple scale of 1–5 at point of last contact; because some could not do standardized QOL tests and many did not do this pre-op to allow comparison. Weights, complications and hospitalizations were obtained by chart review and patient reports. Patient characteristics and measures of weight loss were summarized by mean and standard deviation. Changes from prior periods were tested using a paired *t* test with a null hypothesis of zero change. Categorical variables (e.g., comorbidities) were described by counts and percentages.

### Pre-surgery Preparation

All patients underwent a pre-op endoscopy by a surgeon (KO) to determine the distance of the ring or band from the hiatus, to ensure that we could create an adequate pouch without criss-crossing staple-lines and to exclude SLD in VRG/VBG patients and erosion in band patients. Biopsies were obtained to check for Barrett's and exclude dysplasia because of the prevalence of protracted GERD in these patients. Biopsy proven *Helicobacter pylori* infections were

**Table 1** Literature review of outcomes after revision to proximal gastric bypass

| Year | Author | Surgery type | Number | F/U (years) | ↓BMI(Avg) (pre-bariatric op) | Morbidity mortality |
|---|---|---|---|---|---|---|
| 2008 | Sanchez H et al. Mexico City, Mexico [21] | AGB/ VBG→ LRYGBP | 30 | 1 | 11 | 16.6%/No deaths |
| 2008 | Iannelli A et al. Nice, France [22] | VBG→ LRYGBP | 18 | 2 | 7.4 | 22.2%/5.5% death (6 m later—bleeding marginal ulcer) |
| 2007 | Spivak H et al. Houston, USA [23] | AGB→ LRYGBP | 33 | 1 | 11.8 | 2 reoperations |
| 2006 | Van Wageningen B et al. Netherlands [7] | AGB→ LRYGBP | 47 | 5.5±2 | 11.5 | 17%/No deaths |
| 2005 | Mongol P et al. Paris, France [24] | AGB→ LRYGBP | 70 | 1.5 | 40% of pts failed to have BMI<33 | 20.9%/No deaths early complications—14.3%; late complications—8.6% |
| 2005 | Calmes JM et al. Lausanne, Switz [3] | VBG/ AGB→ LRYGBP | 49 | 4 | >25% of pts failed to have a BMI<35 | 20%/No deaths |
| 2004 | Cordera F et al. Minnesota, USA [4] | VBG→ RYGBP | 51 | 6.1 | 41% of pts failed to have a BMI<35 | 13%/No deaths |

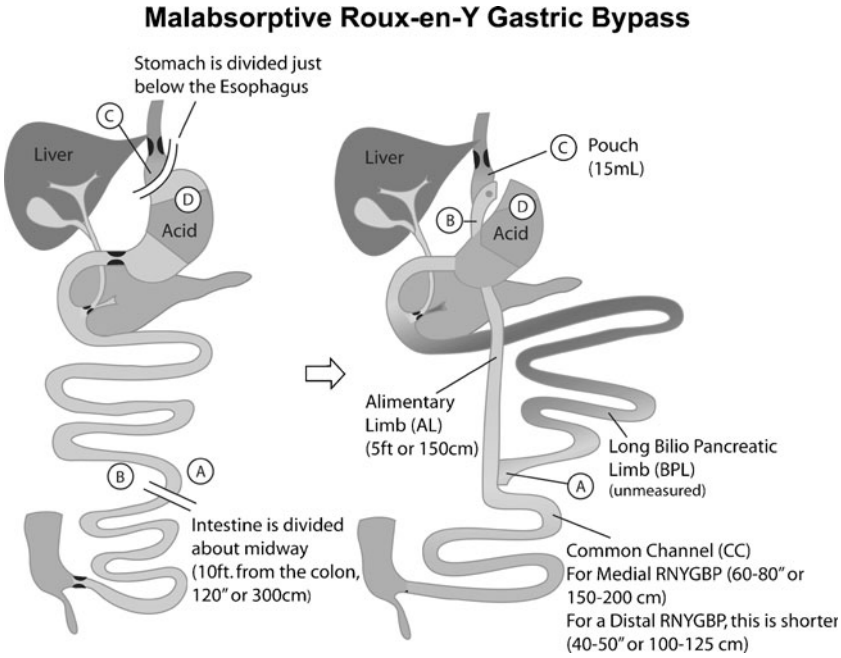


**Fig. 1** Malabsorptive Roux-en-Y gastric bypass (MRNYGBP)

treated pre-operatively. Pre-op weight loss was accomplished with a 10-day sugar-free clear liquid diet supplemented by 30 g of protein, one multivitamin (MV) and one 500 mg calcium citrate pill—each taken three times daily.

## Operative Technique

Our MRNYGBP technique has been published (Fig. 1) [14]. The common channel (CC) was first marked at 150 (100–190) cm above the ileo-cecal valve. CC measurements were snug (not too loose nor under a lot of stretch. Small bowel was transected 150 cm above this point to create a 300 (250–350) cm alimentary limb (AL), leaving a long (not measured) biliopancreatic limb (BPL). The proximal end (A) was anastomosed to the AL at the previous mark to create the CC and the distal end (B) was anastomosed to the pouch (C) via a retrocolic retrogastric route. Mesenteric defect at the enteroenterostomy and Petersen's space were closed. AL was sewn to the mesocolon to close this defect. The anterior stomach was dissected off the liver to liberate the lesser curve and angle of His. The lesser omentum was opened to visualize the caudate lobe. The lesser sac was accessed via the gastrocolic omentum to liberate retrogastric adhesions.

For revision performed until 1996 we used a CC of 100 cm—we were revising predominantly VRGs/VBGs then and we had a larger residual pouch, therefore one of the surgeons (SRF) used a shorter CC to improve weight-loss results. From 1997–1999, we used a 125 cm CC because our pouches were somewhat smaller as we were beginning to revise failed ASGBS as well. After the year 2000, we typically used CC 150 cm or greater because we were creating smaller pouches (approximately 15–20 mL). We were now revising AGBs as well as gastroplasties with smaller pouches to begin with.

VBG/VRG patients (Fig. 2): The gastric window lateral to the ring or mesh was opened. We used an Ethicon TA 55

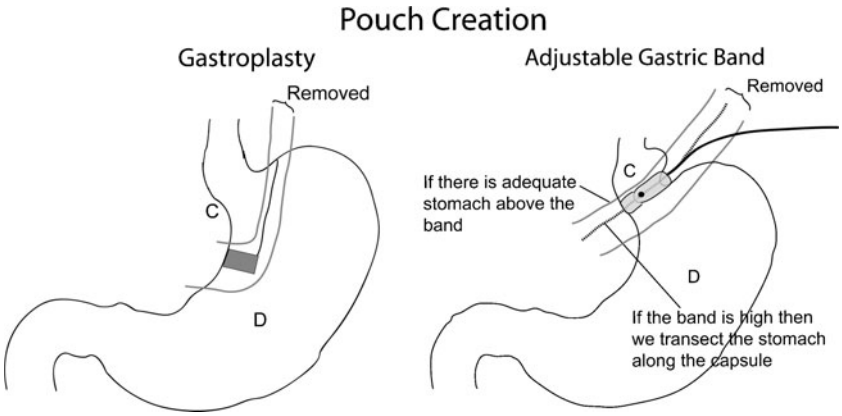


**Fig. 2** Pouch creation

**Table 2** Group characteristics—gastroplasty vs adjustable gastric band groups

| Variable | Gastroplasty ($n$=25) | Adjustable Gastric Band ($n$=13) |
|---|---|---|
| Follow-up (years) | 5.4±1 (1–13) | 4.5±3.0 (1–12) |
| Wt at S1 | 125.0±18.7 (107–191) | 145.2±39.6 (108–243) |
| Wt at S2 | 111.3±22.7 (71–165) | 120.7±30.9 (26–63) |
| BMI at S1 | 46.1±5.5 (39–59) | 41.9±9.9 (36–79) |
| BMI at S2 | 41.1±6.8 (29–55) | 41.9±9.9 (26–63) |
| QOL | 4.5±.6 (3–5) | 4.6±.4 (4–5) |

No statistically significant difference in the two surgery groups in any of the above measures

stapler (green) to amputate the old pouch above the ring/mesh. The old staple-line was marked with 2/0 silk. We used a NG tube in the old pouch to exert medial traction before applying another TA 55 stapler medial to the old staple-line (SL) to create a new vertically oriented lesser curve pouch. The ring/mesh and the old SL were excised completely with a third TA-90 (green) stapler. If the old SL was too far to the left, we removed the fundus and body of the stomach (sparing the antrum) to avoid leaving a poorly drained fundus. ASGB/AGB patients: If there was adequate space above the capsule we created the pouch by excising it, if not we went through it and rarely below it. We focused on leaving a well vascularized pouch with a fresh staple-line (green load). The excluded stomach SL was oversewn with absorbable 3/0 sutures. The lesser curve based gastroenterostomy was performed using a 21 mm EEA stapler. This was reinforced with a running 3/0 absorbable suture which was then buttressed with interrupted 3/0 silk sutures circumferentially and air-tested.

## Follow-up

Patients received rigorous pre-op counseling about the critical importance of life-long compliance with stringent post-surgical nutritional supplementation to prevent malnutrition: Powdered (not pre-made liquid) whey or soy protein 30 g/serving four to five times/day made as thick as possible (usually mixed with no more than 3–4 oz of fluid) to reduce transit time and maximize absorption in the short AL; three MVs four times/day and 1,500 mg of calcium three to five times/day (to maintain 24-h urine calcium (24 h ur ca) levels of 150–300 mg/day), take at least 3 L of fluid daily and avoid eating and drinking simultaneously. They were told to avoid milk (including non-fat milk), sugar, and soft-mushy calorie dense foods/liquids. Cheese and sugar-free yogurt were permitted. Cardiovascular exercise for 45 min/day was recommended. They were on a sugar-free clear liquid diet for the first 4 weeks and transitioned to puree diet over the next 4 weeks before settling on to three to five small high-protein low carbohydrate meals.

Patients were asked to see us monthly during the first year and then at least every 6 months life-long. Patients were also instructed about the importance of life-long nutritional surveillance with labs: comprehensive metabolic panel, lipid profile, phosphorus, magnesium, LDH, GGT, uric acid, CBC, serum iron, total iron binding capacity, % saturation, ferritin, Vit B12, Folate, TSH, Hb A1C, zinc, Vit A, Vit D (25-OH), serum intact PTH, and 24 h ur ca. These labs were obtained pre-operatively, every 3 months in the first year and at least every 6 months thereafter. Prealbumin levels were obtained in hypoproteinemic patients. Vit E, Vit B1, and Vit B6 levels were obtained in anyone with neurological symptoms. Copper and Vit B6 levels were

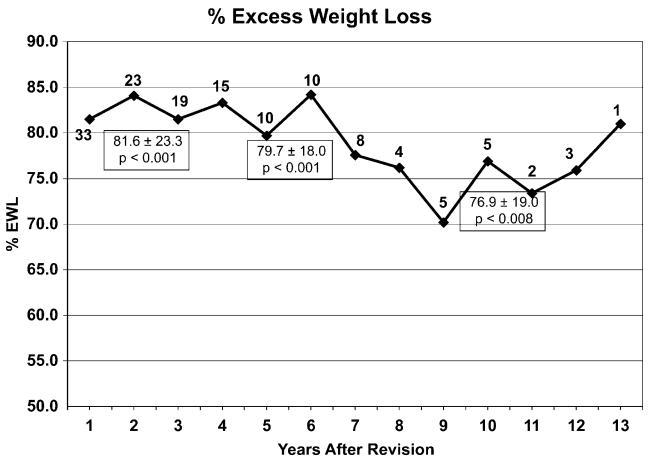


**Fig. 3** %EWL. Total number of patients available for review at each year is shown

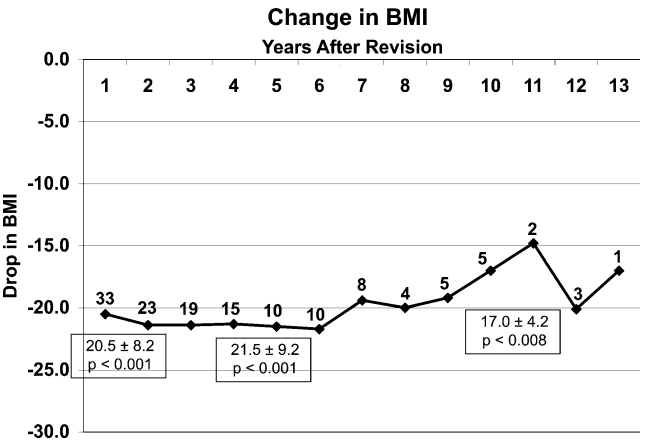


**Fig. 4** Change in BMI

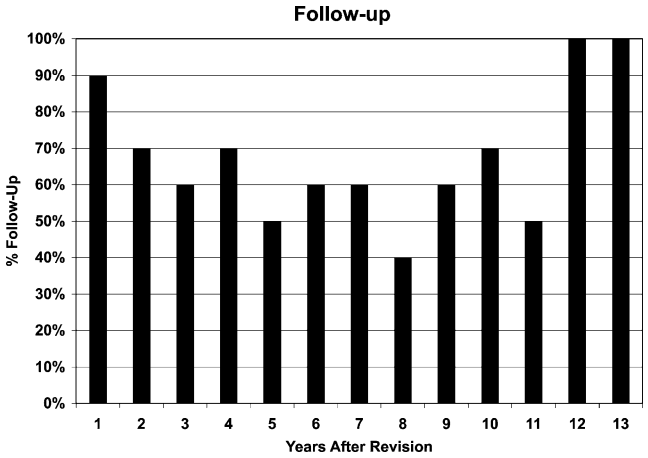


**Fig. 5** Follow-up. Proportion of pts with weight data at a visit they could have potentially attended

obtained in patients with unexplained anemia or leucopenia. Second AM spot urinary N-telopeptide and serum osteocalcin levels were obtained to monitor bone-turnover at least annually. Bone-densitometry at the hips, spine and forearms were obtained at 1-year post-op and every 2 years. The importance of compliance and commitment to protocol was reinforced during each patient visit/contact.

Deficiencies were treated using previously established protocols: VitD—50,000 U of ergocalciferol/day to maintain levels >40 ng/dl. Secondary hyperparathyoroidism that did not respond to Vit D treatment, was controlled using calcitriol 0.25 mcg two to four times/day. Vit A-two to three 10,000 U pills taken four times/day, Vit B12-weekly 1 mg sq injections. Zinc—one to two 15 mg lozenges or 50 mg tablets taken four times a day. Iron-1 g iron sucrose infusion in five 200 mg doses over 2 weeks and supplemented by Chromogen Forte® four times/day.

## Results

Thirty-eight (37 F, 1 M) patients aged 46±8 (17–056) years underwent revision to MRNYGBP 8±5(2–23) years after: gastroplasty-25, adjustable gastric band-13 for weight regain (79%), GERD (29%), and band problems (24%). No statistically significant difference was seen between the groups with respect to age, weight, BMI at S1 or S2, f/u duration or empiric QOL assessment (Table 2). S1 provided only 24±25% EWL (5.9±6.3 BMI drop) and caused GERD in 32% of patients ($p$=0.0124).

BMI dropped from 41.4±7.8 to 27.3±5.6 (down 20.5±8.3 from S1), 80.1±23.3% EWL ($n$=32) at year 1 ($p$< 0.0001). This was maintained for 10 years. From 1 year post-surgery to 10 years post-surgery, EWL continued to decline (at the rate of 1.38% EWL units per year), so we did not see a rebound in weight. F/U: 5.1±3.3 (1–13) years with 83.3% 10 years F/U rate. BMI was 28±4 (21.5–31.9) representing a 17±4 (12–22) drop in BMI or 75.6±21.1% EWL (57.3–109.6) ($n$=5) at 10 years (Figs. 3, 4, and 5) from S1. Super obese patients had better 9.95% EWL after S2 ($p$=0.0359). No patient had a final BMI>35 or a % EWL<50. There was no correlation between CC length and weight loss. %EWL was a bit greater with the shorter CC (<150 cm ($n$=17) vs >150 cm ($n$=21)) but not significantly so. In the group with the shorter <150 cm CC only one pt had a CC of 138 cm, rest had a CC of 125 cm (or 50 in.) or less. In looking at reasons for the second surgery weight regain vs. not, there was no observed difference in weight loss (kg, BMI, or %EWL) between the two groups. The $N$ was low (8 and 30), so the test had little power to detect any difference. QOL (5=excellent): 4.5±0.5 (3–5).

There were no deaths, leaks, post-op intra-abdominal infection, or post-op bleeding. No one required a revision or alteration of their CC to correct malnutrition. Outcomes based on CC length are shown in Tables 3 and 4. Hypoproteinemia (serum protein <6.3 g/dL) was seen 8.3% at 3 years. Patients with malabsorption symptoms were typically due to noncompliance with the recommended supplement protocol and were managed successfully with conservative measures with protein supplements and pancreatic enzyme replacement as needed and improved compliance. None of the patients in this series needed lengthening of the CC because of hypoproteinemia, chronic diarrhea or malodourus flatulence. Patients with CC

**Table 3** Outcome based on common channel (CC) length

| | Common chanel length | | |
|---|---|---|---|
| | <150cm ($n$=17) | >150cm ($n$=21) | Overall ($n$=38) |
| Re-operation | 1 (5.8%)[a] | 1 (4.7%)[b] | 2 (5.2%) |
| Wound infection | 1 (5.8%) | 0 | 1 (2.6%) |
| Hospitalization | 1 (5.8%)[c] | 3 (14.2%)[d] | 4 (10.5%) |
| TPN | 1 (5.8%)[e] 4 m | 1 (4.7%)[f] <1 m | 2 (5.2%) |
| Anemia requiring PRBCs | 1 (5.8%) | 0 | 1 (2.6%) |
| Symptomatic kidney stone | 1 (5.8%) | 0 | 1 (2.6%) |

[a] For bowel obstruction from an internal hernia 2 years after revision

[b] Bowel resection for colitis 4 years after revision

[c] Colitis (4d)

[d] All three patients were admitted for stomal stenosis 1–2 months after surgery for 1–5 days. One pt was on TPN for 1 month

[e] Non-compliance with recommended post-op supplements 6 month after revision. Pt stabilized after resuming supplements and needed no further intervention

[f] Deconditioning 4 m after repair of a massive incisional hernia, abdominal wall reconstruction and panniculectomy performed 3 years after the revision. Pt did not need any further intervention

**Table 4** Malabsorption symptoms based on common channel (CC) length

| | Common chanel length | | |
|---|---|---|---|
| | <150cm ($n$=17) | >150cm ($n$=21) | Overall ($n$=38) |
| Hypocalcemia/Vit D deficiency | 2 (11.8%) | 3 (14.3%) | 5 (13.0%) |
| Anemia | 4 (23.5%) | 1 (4.8%) | 5 (13.0%) |
| Edema | 4 (23.5%) | 2 (9.5%) | 6 (15.8%) |
| Muscle pain | 5 (29.0%) | 0 | 5 (13.0%) |
| Diarrhea | 2 (11.8%) | 3 (14.3%) | 5 (13.0%) |

<150 cm were occasionally treated for short periods of time (less than 2 weeks) with antibiotics (e.g., metronidazole or ciprofloxacin) for flatulence but this was not consistent or repetitive.

Labs before treatment of deficiencies at 3 years ($n$=10) are shown in Table 5. One patient developed pulmonary nodules due to amyloidosis and needed prednisone treatment, resulting in an 11.4 kg weight gain over a year. Another patient gained 12.3 kg after a car accident that prevented her from exercising.

## Discussion

Patients with inadequate weight loss following an anatomically and physiologically intact gastric restrictive operation present a challenging problem. Intangible patient related variables such as dietary and behavioral indiscretion that could contribute to a poor outcome are obviously difficult to evaluate with this study design. The initial weight-loss patients experience after a PRYNGBP is not always sustained [6]. Most studies report a short duration of follow-up. Significant scarring associated with these surgeries increases the risk for perioperative complications such as leaks, infections, and bleeds. We were fortunate that we did not encounter these in this small case series.

There is considerable anatomic variation in construction of a DRNYGBP in the literature. One technique is to move the short (usually 30 cm or less) BPL further downstream to create the shorter CC [15, 16]. This leaves a long AL where calories could be absorbed resulting in less than satisfactory initial weight loss and potential for late weight regain yet leaving the patient with significant side-effects related to the short CC.

The MRNYGBP as we have described above has a long BPL like other "true" malabsorptive operations. This allows for dilution of the biliopancreatic juices before it encounters the food stream. In the earlier years (1993–1998), one of the surgeons (SRF) had used a shorter CC of 100 cm and left a slightly larger pouch. By keeping the CC longer than 100 cm described for the original "true" DRYNGBP and closer to 150 cm in many of these patients (in later years), we noticed less malabsorptive symptoms [17]. In order to distinguish this longer CC from the original DRYNGBP, we have used the term Medial RYNGBP (Med-RNYGBP). A true malabsorptive operation is therefore dictated not just by the CC length but also by a long BPL. As long as this is achieved we could have a malabsorptive operation even though the CC varies from 100 to 190 cm.

Conversion of banded proximal gastric bypass to MRNYGBP has lead to malnutrition but this could have been due to superimposition of significant malabsorption on top of significant restriction imposed by the banded pouch [18]. In the subset of patients who had complete set of labs 3 years out, no one had significant macronutrient deficiency. No patient required re-operation for malnutrition or CC elongation. Should patients develop macronutrient deficiencies that do not respond to conservative treatment we could elongate the CC by moving up the AL proximally along the BPL [19].

Commitment and compliance to a strict post-surgical supplement protocol is essential to prevent post-surgical malnutrition. Nutritional surveillance with serial labs and early correction of nutritional deficiencies is critical for long-term success after any malabsorptive operation [16, 18]. Lack of a comprehensive follow-up and assessment is a significant shortfall in this limited series. Revisional bariatric surgery can be safe, effective, and durable when the appropriate operation is performed in selected patients in experienced hands [20].

**Table 5** Laboratory results ($n$=10 at 3 years post-surgery)

| Variable | Mean | Range |
|---|---|---|
| Total protein | 6.8±.56 g/dl | 5.7–7.7 |
| Albumin | 3.8±.44 g/dl | 3.2–4.6 |
| Serum Iron | 47.6±33.3 mcg/dl | 7.0–97.0 |
| Iron Saturation | 10.3±7.3% | 1.0–24.0 |
| Ferritin | 83.7±119.6 ng/dl | 3.0–309.0 |
| Vit B12 | 620.1±676.5 pg/ml | 100.0–2,000.0 |
| Folate | 14.4±8.8 ng/ml | 1.2–24.0 |
| HCT | 34.1±4.3% | 27.9–39.9 |
| Hb | 11.1±1.7 g/dl | 8.7–13.6 |
| Vit D | 15.1±7.4 ng/ml | 5.0–23.9 |
| PTH | 54.5±27.2 pg/ml | 26.0–85.0 |
| 24 h ur ca | 83.3±24.5 mg/24h | 58.0–107.0 |
| Vit A | 0.23±0.26 mg/dl | 0.004–0.66 |
| Zinc | 40.6±72.1 mcg/dl | 5.1–169.4 |

## Conclusion

Patients who fail to achieve satisfactory weight loss after a gastric restrictive operation are a difficult subset of patients to treat. The MRNYGBP seems to be able to provide long-term durable weight loss in this recalcitrant group of patients. In general a MRNYGBP with CC lengths of >150 cm (AL >300 cm) in patients with a small pouch (e.g., visually estimated to be 15–20 $cm^3$ or less) seem to provide the balance between avoiding malnutrition requiring re-operation and risk of weight regain. Adherence to strict F/U, nutritional surveillance with comprehensive labs, patient education, and early treatment of deficiencies could avert serious nutritional and metabolic problems. Long-term studies focused on nutritional parameters and larger patient series are clearly needed to confirm these observations.

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

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