# One Anastomosis Gastric Bypass Versus Roux-en-y Gastric Bypass Surgery as Revisional Surgery after Restrictive Bariatric Operations

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**Background:** Restrictive bariatric procedures, such as gastric banding and sleeve gastrectomy are technically simple, and effective in achieving weight loss and managing obesity-related comorbidities in the short term. A subset of patients who underwent restrictive bariatric procedures needs revisional surgery for unsuccessful weight loss, gastroesophageal reflux disease, or anatomic complications after primary surgery.

**Aims:** To compare revisional one anastomosis gastric bypass (r-OAGB) against revisional Roux-en-Y gastric bypass (r-RYGB) after failed or complicated restrictive procedures.

**Patients and methods:** This prospective study was conducted on 40 patients who met the inclusion criteria with minimal follow-up of 1 year. Twenty patients were converted to OAGB/MGB and 20 patients were converted to RYGB as a revisional procedure. Both groups were compared for operative time, hospital stay, intraoperative and postoperative complications and short-term outcome.

**Results:** The operative time was significantly longer for r-RYGB with a mean time of 258.25±75.21 mins compared to 216.75±47.30 mins for r-OAGB. Hiatus hernia was found and repaired in 3 patients of the r-OAGB group and 10 patients of r-RYGB. Postoperative complications occurred in 10% of r-OAGB group and 25% of r-RYGB. The mean postoperative weight and BMI were significantly lower than preoperative weight and BMI in both groups with no significant difference between both groups. The mean %EWL was 75.06 ± 24.28 for r-OAGB compared to 64.54 ± 30.40 for r-RYGB therefore EWL% was statistically significant higher after r-OAGB. Overall comorbidities improved in both groups postoperatively while anemia was recorded in 6 patients after r-RYGB compared to 3 patients after r-OAGB.

**Conclusion:** One anastomosis gastric bypass is a simple and effective revisional procedure with less complications, shorter operative time and satisfactory weight loss.

**Key words:** Restrictive bariatric surgery, revisional surg, one anastomosis, roux-en-Y gastric bypass.

## Introduction

Worldwide prevalence of obesity in adults has been increasing across several countries in recent decades.[1,2] A study reported that around 19 million Egyptians (35 % of adults) suffer from obesity. Surgery is the most feasible and effective treatment for morbidly obese patients in long-term weight loss, resolution of co-morbidities. For successful treatment of obesity, patient should be worked-up in a multidisciplinary team for better outcomes in weight loss and morbidity relief in the long term.[3]

Failure of primary bariatric procedures is multifactorial. The definition of failure of a primary bariatric surgery is less than 50% of excess weight lost (EWL), independent of a BMI of >35 m/kg² at 18 months post-operatively, or failure of remission of obesity co-morbidities.[4]

Gastric restrictive procedures included laparoscopic adjustable gastric banding (LAGB), vertical banded gastroplasty (VBG), sleeve gastrectomy (SG) and gastric plication (GP).[5,6] Revision of restrictive bariatric procedures is indicated for patients with insufficient weight loss, weight regain, intolerable gastroesophageal reflux disease (GERD) symptoms or complications either acute or chronic.[7]

Anatomic complications are band erosion, gastric-gastric fistulas, breakdown of a gastric staple line, severe reflux, repair of a marginal ulcer refractory to medications, or malnutrition as a result of intolerance of the primary surgery.[8]

One Anastomosis Gastric Bypass (OAGB) has many advantages as it is a less complex procedure with a greater degree of reversibility with lower opportunities for surgical complications. In addition, it has proven to be technically simple, effective, and safe procedure, also easily revisable, and reversible. It is also highly effective with long term weight loss success.[9] Multiple series showed the efficacy of OAGB as a revisional procedure after failed restrictive operations.[10]

Roux-en-Y Gastric Bypass (RYGB) has excellent weight loss with low mortality rate. It was the

best choice for GERD with obesity. Moreover, it has overall improved health with resolution of co-morbidities (E.g., type II diabetes, hypertension and more). The drawbacks of RYGB are possible obstruction of the jejuno-jejunal anastomosis, risk of internal hernia and marginal ulcer.[11]

RYGB is an effective bariatric revisional surgery after primary restrictive operations with significant reduction in weight and BMI.[12]

**Aim of work**

The aim of this study was to compare between One Anastomosis/Mini-gastric Bypass Surgery and Roux-en-Y Gastric Bypass Surgery as a revisional bariatric surgery as regards operative time, intraoperative complications, length of stay, postoperative complications and short-term outcome.

**Patients and methods**

This is a prospective randomized study conducted on 40 patients, between December 2018 and December 2020 in Ain Shams and Alexandria University Hospitals. Patients were divided into 2 equal groups:

**Group A:** 20 patients who underwent OAGB/MGB (r-OAGB/MGB) as a revisional procedure.

**Group B:** 20 patients who underwent RYGB (r-RYGB) as a revisional procedure.

Approval of the Ethical Committee and written informed consent from all participants were obtained.

**Inclusion criteria**

Any morbidly obese patient who underwent primary restrictive bariatric procedure with failed weight loss, weight regain, gastroesophageal reflux disease or complications after primary bariatric procedure.

**Exclusion criteria**

- Patients who underwent more than one bariatric procedure.
- Patients who had high risk for anaesthesia not candidate for surgery.
- Patient disapproval.

**All patients were subjected to the following:**

**Preoperative assessment**

- Full clinical history and examination.
- Routine preoperative blood tests, chest x-ray, ECG and echocardiography (if indicated).
- Ultrasound of the Abdomen and Pelvis.
- Upper gastro-intestinal endoscopy.
- Upper GIT contrast studies.

**Preoperative quality of life assessment**

The Moorehead-Ardelt Quality of Life Questionnaire II was used.[13]

**Patient counseling**

Patient was educated and supervised about diet instructions. A thorough understanding of operative changes (Including explanation of the operative technique, the anatomical changes, the possible benefits and risks as well as the dietary restrictions and the potential long-term nutritional concerns) is crucial for a better outcome.

All patients were informed about the advantages and disadvantages of the two procedures and consented to be involved in this randomized study. After assigning the procedure to be performed (Using closed envelope technique) the patient signed consent for the procedure.

**Patient preparation**

- Control of any coexisting medical disease, especially coexisting chest diseases, DM and hypertension.
- Prophylaxis against venous thrombosis with low molecular weight heparin.

**Operative details**

1. General anesthesia with endotracheal intubation.
2. Antibiotic prophylaxis before incision in the form of 2 grams of 3rd generation cephalosporins to be injected intravenously after sensitivity test.
3. Elastic stocking or creep bandage was applied to both patients' legs.
4. Patient's positioning.
    - 15 - 30° anti-Trendelenburg tilt with abduction of both arms and thighs where the surgeon stands between patient's legs.
    - The patient is secured with the table straps at the waist.
    - The patient's weight should be distributed on the table.
    - Table attachments should be padded to avoid pressure or nerve injuries particularly in the arms, hands, head, and feet.
    - Patient should be secured on the table and neutrality of joint positioning were re-confirmed before incision.

## 5. Operative technique:

- **Initial steps for both procedures:**
  - Access to the peritoneum was achieved by an optical trocar (12mm) introduced away from primary surgery incisions.
  - Pneumoperitoneum was instituted with a pressure setting of 14–15 mm Hg.
  - Other trocars were inserted under vision according the site of previous adhesions.
  - Additional trocars may be needed for better manipulation.
  - Careful dissection of adhesions of the primary procedure and unfolding the stomach wall were performed. Removal of band and its capsule in case of Adjustable Gastric Band (AGB).
  - Dissection of the esophageal hiatus if a hiatus hernia was found, with posterior crural repair. by nonabsorbable interrupted sutures as illustrated in **(Figure 1).**

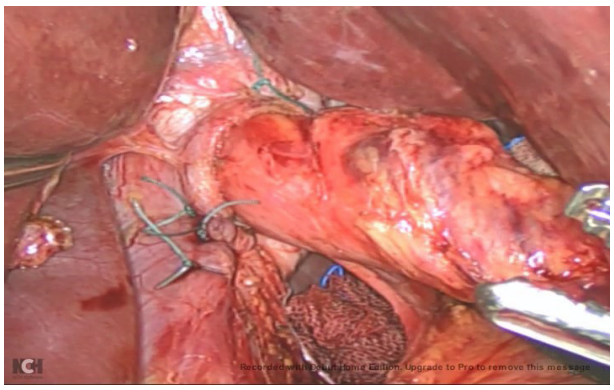

**Fig 1: Dissection of the hiatus and full hiatal repair.**

**Group A:** Creation of a long gastric pouch not less than 9 cm, about 50-150 ml in volume. The lesser curvature of the stomach was identified at the level or just distal to the crow's foot. Here, the stomach was divided horizontally perpendicular to the lesser curve.

A 36 F calibration tube was inserted by the anesthetist, and stapling of the stomach was done parallel to the lesser curvature, to create a longitudinal narrow gastric pouch. In case of previous AGB or VBG, the fundus of the stomach was completely excluded from the gastric pouch. Seromuscular sutures may be added to invaginate the gastric staple line,[14] as shown in **(Figure 2).**

**Fig 2: Creation of long narrow gastric pouch.**

Thereafter, the duodeno-jejunal junction (DJJ) (Ligament of Treitz) is identified by retracting the transverse colon upwards and retracting the omentum from left to right. The small bowel was run to 200 cm distal to Treitz' ligament and then anastomosed antecolic end-to-side to the gastric pouch,[15] as demonstrated in **(Figure 3)**. Additional anti reflux sutures are added between the gastric pouch and the afferent biliopancreatic limb to minimize possible bile reflux. Leak test and hemostasis were performed followed by closure of 12 mm fascial defects. A tube drain was inserted as in **(Figure 4)**.

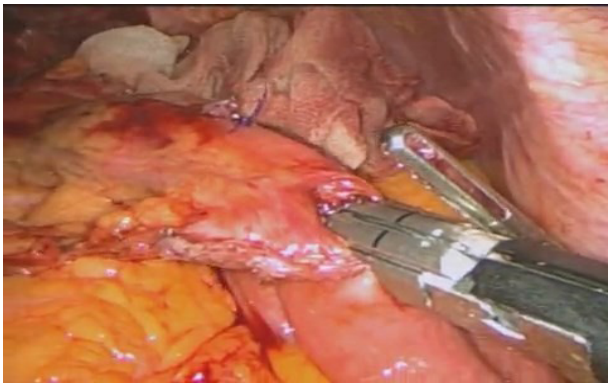

**Fig 3: Gastrojejunal anastomosis.**

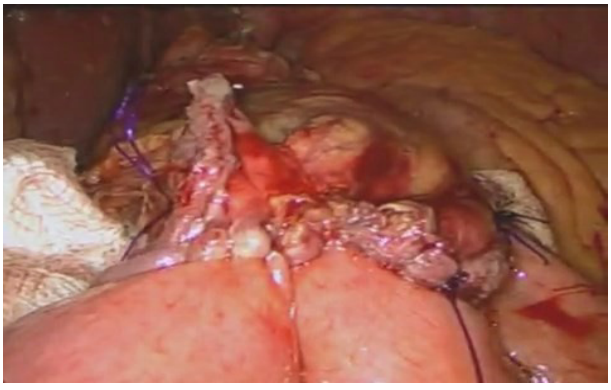

**Fig 4: Leak test.**

**Group B:** Creation of a small gastric pouch. The lesser curvature of the stomach was identified. Here the stomach was stapled and divided at a right angle to the lesser curve. A 36 F calibration tube was passed down by the anesthetist, and the stomach was further stapled and divided upwards parallel to the lesser curvature, so creation of a narrow, short gastric pouch. The fundus was excluded in case of previous AGB or VBG. **(Figure 5).**

**Fig 5: Creation of a short gastric pouch.**

The omentum was retracted to identify the DJJ. The gastro-jejunal anastomosis was performed first with a biliopancreatic limb about 100 cm, and Roux-en-Y alimentary jejunal limb about 100 cm. After that Leak test was performed followed by closure of the mesenteric defects. A drain was inserted with closure of 12mm fascial defects. **(Figure 6).**

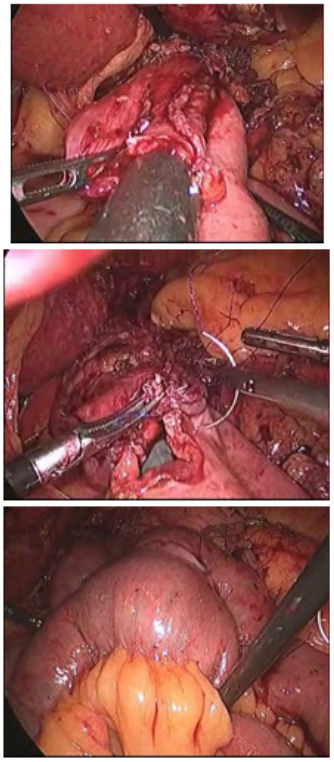

**Fig 6: Enteroenteric anastomosis and leak test.**

**Intraoperative assessment**

- Time of the procedure.
- Difficulties like massive adhesions, bleeding.
- Blood loss and complications.
- Cost of staplers and reloads.

**Data collection**

Data were collected and kept in files including, preoperative, intra-operative and postoperative data.

**Postoperative follow up and instructions:**

**Early postoperative follow up during hospital stay included:**

- Vital signs (Heart rate, Respiratory rate, Temperature and Blood pressure.
- Length of hospital stay.
- Oral intake was started by sips of clear fluids 12 hours postoperatively
- Most patients were discharged from the hospital on the 2nd or 3rd day after operation after tolerating fluid diet.
- Soft diet begun at the 3rd week and regular high protein and low carbohydrate diet at the 5th week after surgery.
- Patients were encouraged to exercise regularly.
- Patients were followed up for detection of early complications (E.g.: bleeding, gastric leakage, DVT, respiratory and cardiovascular complications) and managed accordingly.
- Low molecular weight heparin was given for two weeks postoperatively.

Patients were instructed to visit regularly and follow up investigations were performed after 6 months and one year in the form of: CBC, serum iron, TIBC, Ca total and ionized, vit D, FBS, HbA1c and serum albumin.

Follow up anthropometric measurements were recorded as weight and BMI after 12 months, and Percentage of Excess Weight Loss (EWL%).

**% EWL was calculated according to the following formula:**

$$\%\ EWL = \frac{(\text{preoperative weight} - \text{current weight})}{(\text{preoperative weight} - \text{ideal weight})} \times 100$$

We recorded resolution of co-morbidities, readmission rate and postoperative complications.

Quality of life and eating behavior assessment was performed after 12 months follow up.

**Statistical analysis of the data**

Data were fed to the computer and analyzed by the use of IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp) Qualitative data were described using numbers and percentages. Shapiro-Wilk test was used to verify the normality of distribution. Quantitative data were described using range (Minimum and maximum), mean, standard deviation, median and interquartile range (IQR). Significance of the obtained results was judged at the 5% level.

**Results**

**I. Preoperative assessment**

Demographic characteristics showed no difference in both groups **(Table 1).**

Preoperative comorbidities were found in 37 patients (92.5%), 17 patients of group A and 20 patients of group B. GERD was the most common co-morbid condition in group B (15 patients; 75%), significantly higher than the number of GERD patients in group A (7 patients; 35%) **(Table 2).**

Routine laboratory investigations were done. All values were within normal range except for 3 patients (15%) in group A and 3 patients (15%) in group B who had mild anemia.

Routine abdominal ultrasound showed mild fatty liver infiltration in 16 patients (80%) in group A and 14 patients (70%) in group B. In group A, there were 3 patients with chronic calcular cholecystitis and 1 patient with a history of cholecystectomy, compared to 2 patients and 1 patient in group B respectively.

Routine upper GIT endoscopy was done and revealed a small hiatal hernia in 6 patients of group A and 7 patients of group B. Moderate sized hiatal hernia was found in only 2 patients of group B. Reflux esophagitis was found in 2 patients (10%) of group A and 6 patients (30%) in group B. The number of patients who had hiatal hernia and reflux esophagitis was higher in group B. Other findings included big fundus, big antrum, weak esophago-gastric junction, Staple line disruption, gastritis widely plicated stomach, narrow pouch, wide pouch and gastro gastric fistula.

Upper GI contrast studies were done in some selected cases. CT gastric volumetry was done in 3 patients of group A which revealed small sliding hiatal hernia in 2 patients and big fundus with narrowing at incisura in 1 patient. While 5 patients in group B did GI contrast studies. CT Gastric volumetry showed small sliding hiatal hernia with wide stomach in 1 patient. Barium meal was done in 3 patients and 2 of them showed small sliding hiatal hernia with big antrum. Oral Gastrografin showed delay in upper stomach with narrowing at incisura in 1 patient.

Preoperative quality of life was assessed by using the Moorehead-Ardlet Quality of life Questionnaire II. In group A, 9 patients (45%) scored fair, 7 patients (35%) scored poor and 4 patients (20%) scored very poor, but in group B, only 3 patients (15%) scored fair, 9 patients (45%) scored poor and 8 patients (40%) scored very poor. Data were compared with postoperative QOL in table 6.

Primary procedures in group A were LSG in 9 patients, AGB in 7 patients, VBG in 2 patients and gastric plication in 2 patients. While in group B, there were 10 patients with primary LSG, AGB in 1 patient, VBG in 6 patients and gastric plication in 3 patients.

The reasons for revision were weight regain and GERD with reflux esophagitis as shown in **(Figure 7)**.

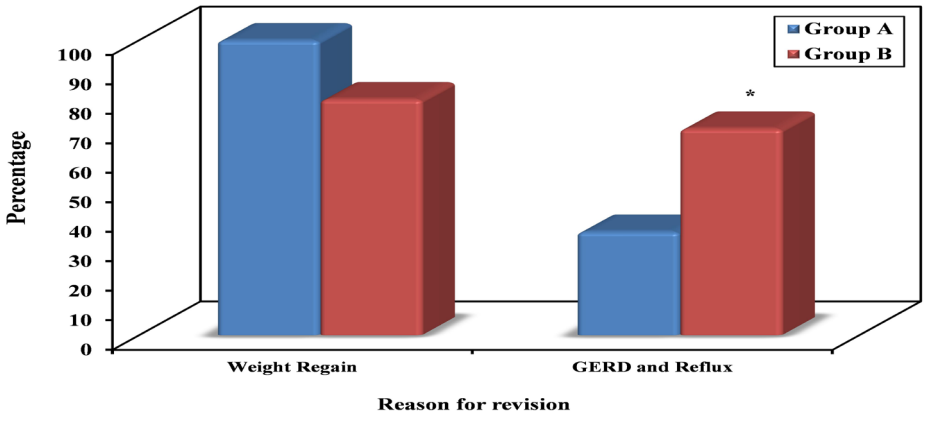


**Fig 7: Comparison between the two studied groups according to reason for revision of primary procedures in preoperative assessment.**

The duration between primary and revisional operations in group A ranged from 2 – 16 years compared to 2 – 25 years in group B with no statistically significant difference.

## II. Operative assessment

The revisional procedures in both groups were completed laparoscopically. During revision of group A, associated procedures were done in 6 patients. Three patients did hiatal hernia repair and 3 patients did cholecystectomy. While, during revision of group B associated procedures were done in 12 patients. Ten patients did hiatal hernia repair and 2 patients did cholecystectomy.

Mean operative time in group A was 216.75 ± 47.30 mins (range 140 - 320 mins) compared to 258.25 ± 75.21 mins (range 180 – 480 mins) in group B. The operative time in group A was significant less than group B. **(Figure 8).**

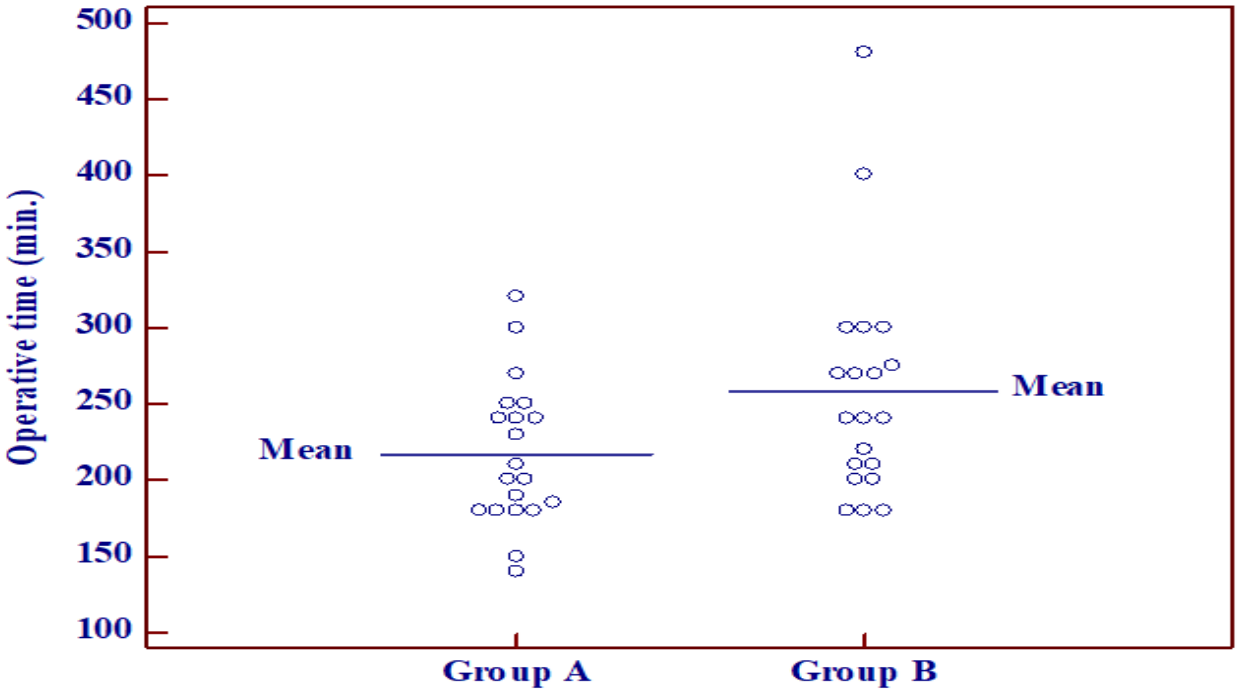


**Fig 8: Comparison between the two studied groups according operative time (Min.).**

The blood loss was determined by the severity of adhesions and the duration of procedure. It was measured by amount of blood in the suction device and the number of soaked gauzes inserted intraoperatively. Blood loss was minimal in all (20) patients of group A while in group B, it was minimal in 16 patients and mild in 4 patients. There was no significant difference.

The cost of the procedure was estimated by the number of stapler's reloads used as the remaining instruments were similar in all patients like staplers, trocars and vessel sealing device. The number of reloads varied from 4 to 8 reloads in each group with a mean number 6.25 ± 0.85 in group A and 6.05 ± 1.0 in group B, with no statistically significant difference.

Intraoperative difficulties were faced in the form of adhesions, narrow intra-abdominal space and difficult trocars manipulation due to excess subcutaneous abdominal fat. There were adhesions in all studied patients (100%) but severity of adhesions was different.[16]

Intraoperative complications occurred in 3 patients (15%) of group A as well as group B. Complications of group A included postoperative hypoventilation that necessitated ICU observation oxygenation. The patient was transferred to her room on the 1st postoperative day. She was discharged on the 3rd day postoperatively. Stapler misfiring occurred in one case after the 2nd longitudinal reload during creation of gastric pouch. It occurred due to the presence of previous hemostatic clip in the way of the stapler knife. It was managed by two layers sutures. Iatrogenic gastric pouch perforation that occurred during dissection in 1 patient and was managed by suture closure of the opening of the stomach. **(Figures 9,10).**

Complications of group B included iatrogenic gastric pouch perforation during dissection in 2 patients. They were closed by two layers of sutures. In one case accidental hematoma to the mesentery of the Roux limb occurred in 1 patient and could be controlled by compression.

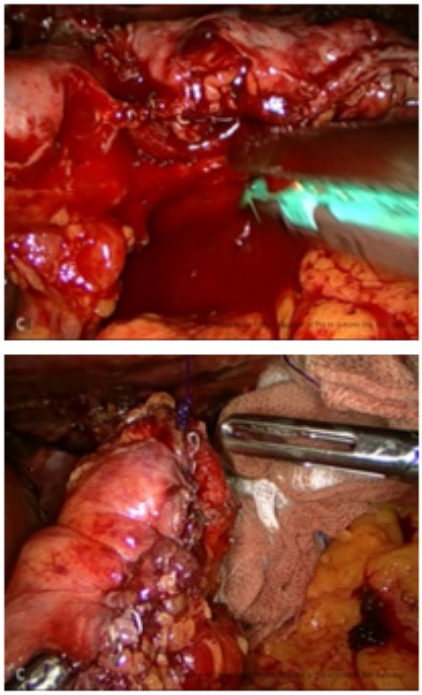

**Fig 9: Misfiring of the stapler & suturing in two layers.**

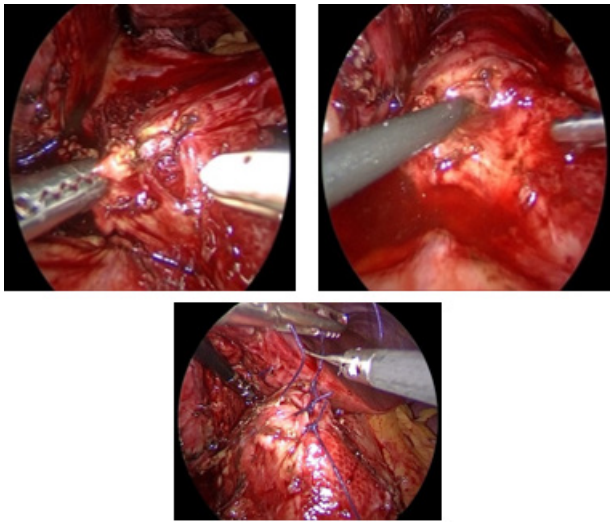

**Fig 10: Iatrogenic pouch perforation & sutured and did the anastomosis above it.**

### III. Early Postoperative Complications:

One patient in group A stayed 4 days and one patient in group B stayed 7 days in the hospital due to complications and re-exploration. One patient in group A, four patients in group B required readmission as they developed postoperative complications. The readmission rate was higher in group B patients. **(Table 3).**

Postoperative complications occurred in 5 patients (25%) of group B compared to 2 patients of group A (10%).

The first group A patient had a big intraperitoneal collection under the left lobe of the liver figure 11. Re-exploration was performed. Evidence of leakage could not be found. Conversion to RYGB was performed **(Figure 13).** The second patient had port site infection which was managed conservatively by antibiotics and fomentations.

While in group B, Turbid intraperitoneal collection was found in 1 patient on laparoscopic re-exploration without leakage. The second patient complained of abdominal pain, hematemesis and vomiting. Contrast CT study of the abdomen and endoscopy revealed no definite abnormality. Therefore, conservative management was successfully applied. One patient was vitally unstable in the early postoperative period. Contrast CT study of the abdomen and chest revealed no definite abnormality. As the patient deteriorated, laparoscopic exploration was performed and revealed missing jejunal loop perforation. Resection and anastomosis of the perforated segment was performed. One patient presented by severe abdominal pain and colic. Contrast CT study of the abdomen showed internal hernia. Laparoscopic exploration revealed hernia in Peterson space with no bowel ischemia. Closure of the defect by nonabsorbable sutures was carried out. The last patient presented by bleeding per rectum that was successfully managed conservatively. **(Figures 11-14).**

**Re exploration & 2nd look laparoscopy**

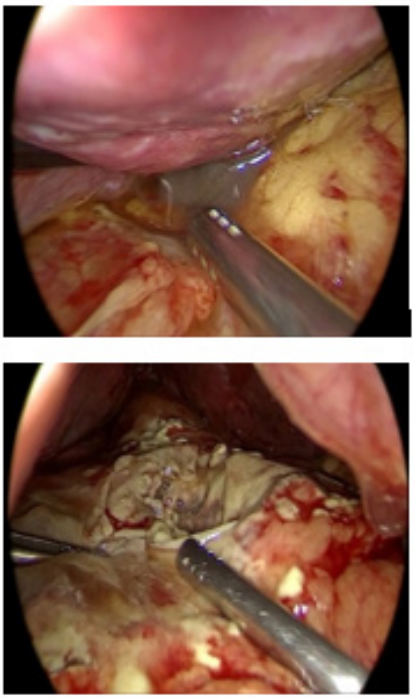

**Fig 11: Large IP collection under the left lobe of the liver.**

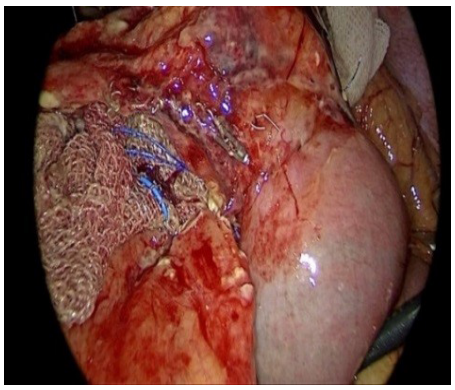

**Fig 12: Leak test for GJ anastomosis was negative.**

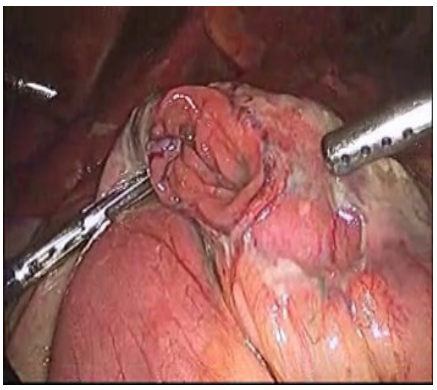

**Fig 14: Missing jejunal loop perforation.**

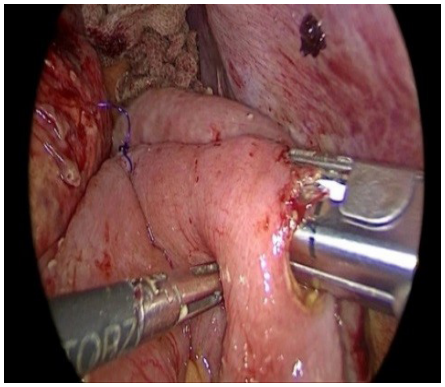

**Fig 13: Conversion to RYGB.**

### IV. Postoperative Clinical Outcome:

The follow up rate was 100% where all patients completed 12 months follow up and were also evaluated for weight loss, co-morbidity improvement or resolution, and quality of life.

Weight in kilograms of both groups was found statistically significant after periods of 2 weeks, 3 months till 12 months **(Figure 15).**

Mean postoperative BMI at 12 months was significant low than preoperative BMI in both groups **(Table 4).**

The mean Excess Weight Loss % was 75.06 ± 24.28 in group A compared to 64.54 ± 30.40 in group B therefore EWL% was statistically significant higher in group A. One patient in group B was excluded from postoperative EWL% comparison. This patient lost 10 kg after 1 year with r-RYGB while her excess weight was 3.71 kg so the EWL% for that excluded case was 269% **(Figure 16).**

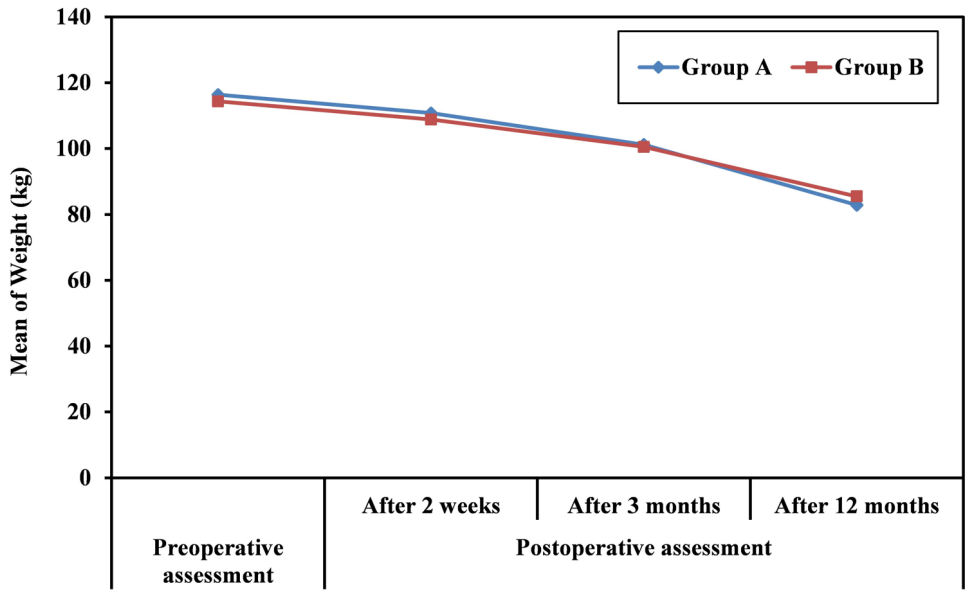


**Fig 15: Descriptive analysis of the studied groups according to weight in each period.**

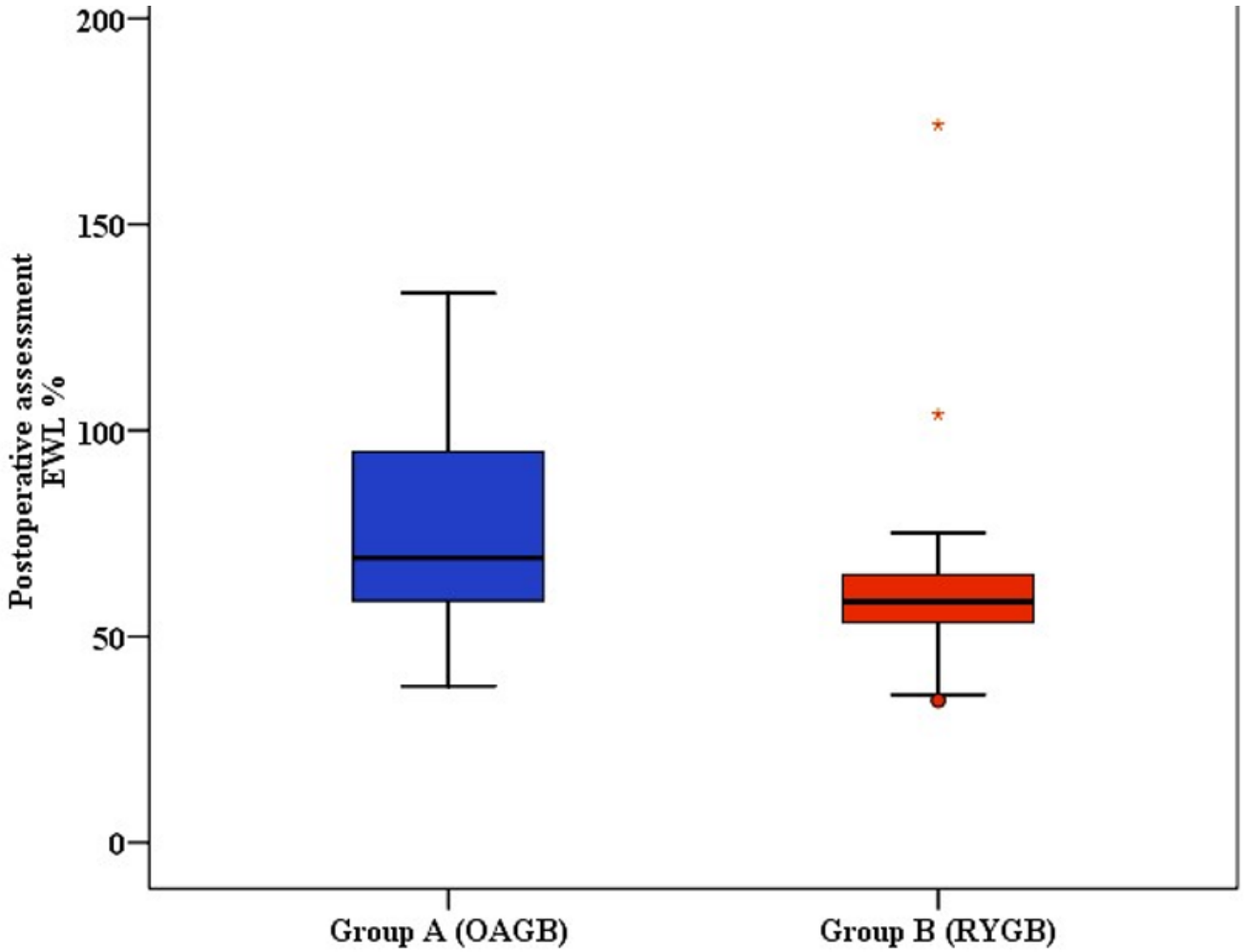


**Fig 16: Comparison between the two studied groups according to postoperative assessment EWL %.**

There was no statistically significant difference between groups A and B as regards 12 months postoperative weight loss. All data was summarized in **(Table 5).**

However, there was a statistically significant difference between 12 months weight loss with revisional procedures and the nadir weight loss of primary restrictive procedures in group B. (Very difficult to compare, as it depends on the primary procedure).

Overall co-morbidities showed evident improvement in both groups after 12 months. **(Table 6).**

The results of postoperative Quality of life assessment in the areas of general self -esteem, physical activity, social contacts, satisfaction concerning work, and eating behavior are summarized in **(Table 7)**.

As regards postoperative quality of life assessment, all patients had a good, very good or fair outcome, reflecting the overall level of satisfaction of patients. In r-OAGB, 16 patients (80%) had a good outcome, 3 patients (15%) had a very good and only one (5%) scored fair. On the other hand, in r-RYGB, 15 patients (75%) had a good outcome, 2 patients (10%) had very good and 3 patients (15%) scored fair.

Follow-up 12 months laboratory investigations showed no statistically significant difference between both groups. Anemia could be detected in 6 patients of group B and 3 patients in group A. The mean Hb level was significantly decreased in group B patients from 12.34 ± 1.64 to 11.53 ± 1.89 at 12 months follow up. Serum Albumin level was normal in all patients of group A and B.

**Table 1: Comparison between the two studied groups according to demographic data**

| Demographic data | Group A (n=20) | | Group B (n=20) | | P |
|---|---|---|---|---|---|
| | No. | % | No. | % | |
| **Gender** | | | | | |
| Male | 5 | 25.0 | 3 | 15.0 | $^{FE}$p= 0.695 |
| Female | 15 | 75.0 | 17 | 85.0 | |
| **Age (years)** | | | | | |
| Min. – Max. | 33.0 – 67.0 | | 25.0 – 60.0 | | 0.185 |
| Mean ± SD. | 46.65 ± 8.69 | | 42.80 ± 9.33 | | |
| **Weight (kg)** | | | | | |
| Min. – Max. | 80.0 – 191.0 | | 51.50 – 175.0 | | 0.925 |
| Mean ± SD. | 116.35 ± 29.91 | | 114.34 ± 33.15 | | |
| **Height (cm)** | | | | | |
| Min. – Max. | 145.0 – 179.0 | | 149.0 – 173.0 | | 0.737 |
| Mean ± SD. | 161.70 ± 7.44 | | 161.0 ± 5.49 | | |
| **BMI (kg/m²)** | | | | | |
| Min. – Max. | 28.37 – 70.41 | | 19.87 – 78.83 | | 0.980 |
| Mean ± SD. | 44.25 ± 9.72 | | 44.16 ± 13.28 | | |
| **Excess weight (kg)** | | | | | |
| Min. – Max. | 9.75 – 118.75 | | -13.30 – 119.50 | | 0.947 |
| Mean ± SD. | 50.85 ± 27.35 | | 49.46 ± 32.67 | | |

IQR: Inter quartile range. SD: Standard deviation. x2: Chi square test. FE: Fisher Exact.
U: Mann Whitney test. t: Student t-test. p: P value for comparing between the two studied groups.
Group A: OAGB. Group B: RYGB.

**Table 2: Comparison between the two studied groups according to preoperative Co–morbidities**

| Preoperative Co–morbidities | Group A (n=20) | | Group B (n=20) | | P |
|---|---|---|---|---|---|
| | No. | % | No. | % | |
| GERD | 7 | 35.0 | 15 | 75.0 | 0.011* |
| Knee pain | 14 | 70.0 | 10 | 50.0 | 0.197 |
| Back pain | 8 | 40.0 | 7 | 35.0 | 0.744 |
| HTN | 2 | 10.0 | 4 | 20.0 | $^{FE}$p=0.661 |
| DM | 1 | 5.0 | 5 | 25.0 | $^{FE}$p=0.182 |
| Dyslipidemia | 2 | 10.0 | 2 | 10.0 | $^{FE}$p=1.000 |
| Dyspnea | 7 | 35.0 | 10 | 50.0 | 0.337 |
| Depression | 3 | 15.0 | 3 | 15.0 | $^{FE}$p=1.000 |

$\chi^2$: Chi square test. FE: Fisher Exact. p: P value for comparing between the two studied groups.
*: Statistically significant at p ≤ 0.05. Group A: OAGB. Group B: RYG.

**Table 3: Comparison between the two studied groups regarding Hospital stay**

| Postoperative assessment | Group A (n=20) | | Group B (n=20) | | P |
|---|---|---|---|---|---|
| | No. | % | No. | % | |
| **Hospital Stay** | | | | | |
| Min. – Max. | 2.0 – 4.0 | | 2.0 – 7.0 | | |
| Mean ± SD. | 2.15 ± 0.49 | | 2.25 ± 1.12 | | 0.820 |
| Median (IQR) | 2.0 (2.0 – 2.0) | | 2.0 (2.0 – 2.0) | | |

$\chi^2$: Chi square test. FE: Fisher Exact. U: Mann Whitney test. p: P value for comparing between the two studied groups.
Group A: OAGB. Group B: RYGB.

**Table 4: Comparison between the two studied groups according to BMI**

| BMI (kg/m²) | Group A (n=20) | Group B (n=20) | P |
|---|---|---|---|
| **Preoperative assessment** | | | |
| Min. – Max. | 28.37 – 70.41 | 19.87 – 78.83 | 0.980 |
| Mean ± SD. | 44.25 ± 9.72 | 44.16 ± 13.28 | |
| **Postoperative after 12 months** | | | |
| Min. – Max. | 23.40 – 50.60 | 22.30 – 50.40 | 0.496 |
| Mean ± SD. | 31.43 ± 7.44 | 33.0 ± 6.99 | |
| **$t_0$ ($p_0$)** | 16.138* (<0.001*) | 7.023* (<0.001*) | |

IQR: Inter quartile range. SD: Standard deviation. t: Student t-test. $t_0$: Paired t-test.
p: P value for comparing between the two studied groups.
$p_0$: P value for comparing between preoperative and postoperative assessment in each group.
*: Statistically significant at p ≤ 0.05. Group A: OAGB. Group B: RYGB.

**Table 5: Comparison between the two studied groups according to weight loss at 12 months with revisional procedures compared to weight loss with primary procedures**

| Weight loss (kg) | Group A (n=20) | Group B (n=20) | P |
|---|---|---|---|
| **Primary procedures** | | | |
| Min. – Max. | 9.0 – 105.0 | 15.0 – 61.50 | 0.429 |
| Mean ± SD. | 39.73 ± 21.49 | 40.67 ± 13.69 | |
| Median (IQR) | 30.0 (25.0–51.0) | 39.0 (32.0–53.0) | |
| **Revisional procedures** | | | |
| Min. – Max. | 13.0 – 50.0 | -10.0 – 63.0 | 0.301 |
| Mean ± SD. | 33.50 ± 9.84 | 28.83 ± 17.76 | |
| Median (IQR) | 34.0 (26.50–41.75) | 26.25 (17.0–40.35) | |
| **Z ($p_0$)** | 0.672 (0.501) | 2.035*(0.042*) | |

IQR: Inter quartile range. SD: Standard deviation. U: Mann Whitney test. Z: Wilcoxon signed ranks test.
p: P value for comparing between the two studied groups. $p_0$: P value for comparing between primary and revisional procedures in each group.
*: Statistically significant at p ≤ 0.05. Group A: OAGB. Group B: RYGB.

**Table 6: Comparison between the two studied groups according to Co–morbidities (Postoperative assessment)**

| Co–morbidities (Postoperative assessment) | Group A | | Group B | |
|---|---|---|---|---|
| | No. | C (%) | No. | C (%) |
| GERD | 7 | 7 (100.0) | 15 | 15(100.0) |
| Knee pain | 14 | 14(100.0) | 10 | 10(100.0) |
| Back pain | 8 | 7 (87.5) | 7 | 4 (57.1) |
| HTN | 2 | 2 (100.0) | 4 | 4 (100.0) |
| DM | 1 | 1 (100.0) | 5 | 5 (100.0) |
| Dyslipidemia | 2 | 2 (100.0) | 2 | 2 (100.0) |
| Dyspnea | 7 | 7 (100.0) | 10 | 9 (90.0) |
| Depression | 3 | 3 (100.0) | 3 | 0 (0.0) |
| Total | 44 | 43 (97.7) | 56 | 49 (87.5) |
| $\chi^2$ ($^{FE}$p) | 3.502 (0.075) | | | |

$\chi^2$: Chi square test. FE: Fisher Exact p: P value for comparing between the two studied groups.
Group A: OAGB. Group B: RYGB.

**Table 7: Comparison between the two studied groups as regards QoL**

| QOL assessment | Group A (n=20) | | Group B (n=20) | | $^{MC}p$ |
|---|---|---|---|---|---|
| | No. | % | No. | % | |
| **Preoperative** | | | | | |
| Very poor | 4 | 20.0 | 8 | 40.0 | |
| Poor | 7 | 35.0 | 9 | 45.0 | |
| Fair | 9 | 45.0 | 3 | 15.0 | 0.113 |
| Good | 0 | 0.0 | 0 | 0.0 | |
| Very good | 0 | 0.0 | 0 | 0.0 | |
| **Postoperative** | | | | | |
| Very poor | 0 | 0.0 | 0 | 0.0 | |
| Poor | 0 | 0.0 | 0 | 0.0 | |
| Fair | 1 | 5.0 | 3 | 15.0 | 0.741 |
| Good | 16 | 80.0 | 15 | 75.0 | |
| Very good | 3 | 15.0 | 2 | 10.0 | |
| $^{MH}p$ | <0.001* | | <0.001* | | |

QoL: Quality of life. $\chi^2$: Chi square test. MC: Monte Carlo.
p: P value for comparing between the two studied groups.
p: p value for Marginal Homogeneity Test for comparing between preoperative and postoperative.
*: Statistically significant at $p \leq 0.05$. Group A: OAGB. Group B: RYGB.

## Discussion

The majority of bariatric patients do achieve successful outcomes after their primary surgery,[17] however failure is quite high. Failure rates have been reported ranging between 40% and 50%, with 20% to 30% of patients requiring a revisional operation.[18] Unsuccessful weight loss and anatomic complications are the most common causes for pursuing revisional surgery.[19]

Revisional procedures are complex and technically demanding. They are generally associated with a higher risk of postoperative risks and complications than that of primary procedures, and the perioperative morbidity rate is about 19%-50%.[20]

This prospective study was conducted on 40 patients, who were selected to meet our inclusion criteria and were operated on after careful preoperative assessment with minimal follow-up of 1 year. Patients were divided into two equal groups; group A underwent r-OAGB and group B underwent r-RYGB.

In the current study, the mean age was 46.65 ± 8.69 years and 42.80 ± 9.33 years for group A and B respectively. There was no significant difference between both groups as regards the mean preoperative BMI. It was 44.25 ± 9.72 kg/m$^2$ for group A and 44.16 ± 13.28 kg/m2 for group B.

Co-morbidities among patients before revision included: GERD (35% in group A and 75% in group B), knee pain (70% in group A and 50% in group B), back pain (40% in group A and 35% in group B), hypertension (10% in group A and 20% in group B), diabetes mellitus (5% in group A and 25% in group B), dyslipidemia (10% in group A and 10% in group B), dyspnea (35% in group A and 50% in group B) and depression (15% in group A and 15% in group B).

Primary procedures in group A were LSG in 9 patients, AGB in 7 patients, VBG in 2 patients and gastric plication in 2 patients. While in group B, there were 10 patients with a history of LSG, 1 patient with AGB, 6 patients with VBG and 3 patients with gastric plication.

The reason for revision in group A was weight regain in all,[20] patients with GERD and reflux esophagitis in 7 of them. For group B, 16 patients underwent RYGB because of weight regain, 10 of these 16 patients had both weight regain and GERD with reflux esophagitis. Only 4 patients had GERD and reflux esophagitis in the absence of weight regain.

A study by Chiappetta (2019) and her colleagues that compared between MGB and RYGB as a second step operation after SG showed that the causes of revision to MGB in 34 patients were inadequate weight loss in 64.7%, weight regain in 20.5% and GERD in 14.7%.[21]

A study done by Sabry et al., (2020) that assessed the effect of MGB as a revisional procedure after failed primary restrictive bariatric surgery

showed that the causes of revision to MGB in 60 patients were insufficient weight loss in 20 patients (33.33%), weight regain in 21 patients (35%), gastroesophageal reflux disease (GERD) in 15 patients (25%) and band slippage or food intolerance in 4 patients (6.66%).[22]

The mean operative time in group A was 216.75 ± 47.30 mins compared to 258.25 ± 75.21 mins in group B. Consequently, there was a statistically significant increase in group B operative time (R-RYGB). During revision of group B, associated procedures (Hiatal repair &cholecystectomy) were done in 12 patients compared to 6 patients in group A (r-OAGB). The mean length of hospital stay was 2.15 days (2-4) for group A and 2.25 days (2-7) for group B.

A recent systematic review of 1075 patients by Parmar et al., (2020) showed that the mean operative time of r-OAGB was 119.3 min. The mean length stay was 4.01 days (2–28).[23]

Khoursheed, et al., (2013) published results revealed the mean operative time in r-RYGB was 161.2 min and the median hospital stay was 3 days.[24]

Salama and Sabry (2016) published results on 60 patients that showed that the mean operative time of r-MGB after VBG was 145.41 minutes compared to 185.16 min with r-RYGB.[25]

Compared to the published results by Frantzides, et al., (2019) about laparoscopic r-RYGB of failed AGB and VBG showed that the average operative times were 185 and 205 minutes and the average hospital stay was 1.5 and 2.5 days, respectively.[26]

Elmahdy (2021) published a recent study about laparoscopic revisional OAGB for failed open VBG for management of morbid obesity. It showed that the mean operative time was 145.36±25.19 min, and the mean hospital stay was 3.12 days.[27]

Intraoperative complications occurred equally in 3 patients of each group. Postoperative hypoventilation and dyspnea necessitating ICU admission for oxygenation and monitoring occurred in one case, stapler misfiring in the second case and iatrogenic gastric pouch perforation in the third case in group A.

Complications in group B included iatrogenic gastric pouch perforation in two cases and accidental hematoma to the mesentery in one case.

A study by Zhang et al., (2015) on perioperative risks of revisional RYGB versus primary RYGB showed that there was higher risk for postoperative ICU stay (N=24, 14% vs. n=2, 1%), and longer stay of the hospital (5.6 vs. 2.5 days). Intraoperative liver injury was significantly higher (N=13, 8% vs. n=1, 1%). Also, spleen injuries were more common (N=18, 10% vs. n=0), in addition to more enterotomies (N=9, 5% vs. n=0) in the revisional group compared to the primary group.[28]

A study by Stefanidis et al., (2013) on revisional bariatric surgery reported that revisional bariatric surgeries have higher rates of readmissions and complications, however, there was no differences in leakage rates and mortality compared with primary surgeries.[29]

Postoperative complications occurred in two patients (10%) of group A in the form of intraperitoneal big collection that was drained and converted to RYGB and port site infection. While five patients (25%) of group B developed complications such as turbid intraperitoneal collection with no leak, abdominal pain associated with hematemesis, missing jejunal loop perforation, internal hernia and bleeding per rectum.

A study by Almalki and his colleagues (2018) about revisional gastric bypass on 116 patients showed that complications developed in 12 patients (10%), moreover, there was no significant difference between r-OAGB group and r-RYGB group.[30]

Recent systematic review of literature by Velotti et al., (2021) reported that both RYGB and OAGB had a similar rate of leak but OAGB had a minimal rate of bleedings.[31]

Weight in kilograms of both groups decreased significantly after 2 weeks, 3 months till 12 months. The mean postoperative BMI at 12 months (31.43 ± 7.44 in group A and 33.0 ± 6.99 in group B) showed significant decline than preoperative BMI (44.25 ± 9.72 and 44.16 ± 13.28 for group A and B) respectively.

Similar results were reported in the study done by Bruzzi and his colleagues (2016) where the mean BMI before revision was 45.5±7 kg/m$^2$ and reduced to 33 ± 4.5 kg/m2 after one year of follow up.[32]

Results of Hamdi et al., (2014) showed that postoperative BMI average at 12 months was 33.0. Weight loss was statistically significant after 3 months till 12 months.[33]

Many studies revealed the efficacy of revisional OAGB in weight loss and comorbidities reduction after failed restrictive operations, mean BMI range from 33 to 36.5 at 12 months follow up is reported.[32,34]

The weight loss 12 months after r-RYGB is significantly lower than the nadir weight after the primary procedure.

The mean EWL% after 12 months with r-OAGB was

75.06 compared to 64.54 with r-RYGB therefore EWL% was statistically significant higher with r-OAGB.

Rutledge (2006) published a study revealed that mean %EWL was 72% in LAGB-MGB group after 1 year.[35]

Topart et al., (2009) report similar %EWL at one year with r-RYGB after failed adjustable gastric banding (66.1%).[36]

Our study showed 100% resolution of DM, hypertension, dyslipidemia, GERD and knee pain in patients of both groups after 12 months. Dyspnea was cured in 100% of r-OAGB and 90% of r-RYGB. Back pain improved in 87.5% of r-OAGB and 57.1% of r-RYGB. Depression improved in 100% of r-OAGB while not improved in r-RYGB (0%). There was evident improvement of overall co morbidities with total cure percent 97.7% in r-OAGB and 87.5% in r-RYGB.

A study done by Mohamed et al. (2021) published about outcome of mini gastric bypass after failure of VBG showed 100% resolution of hypertension and remission of diabetes in 86.7% of patients one year after surgery. The remaining cases showed improvement in diabetic state observed in reduction of the daily dose of oral hypoglycemic drugs.[37]

A study published by Abdulrazzaq et al. (2020) showed that the T2DM remission rate with r-RYGB was 66.7% but hypertension rate was 37.5%.[38]

Vallois et al. (2018) published results revealed comorbidities improvement after 1 year of r-RYGB including diabetes (73.7%), hypertension (62.5%) and obstructive sleep apnea syndrome (100%).[39]

At 12 months follow up investigations, r-RYGB had a significantly lower Hb level.

However, Almalki et al., (2018) reported a significantly lower hemoglobin level was found in r-OAGB group in them results.[30]

## Conclusion

Based on the findings of our study, Both OAGB and RYGB are acceptable options for revision of restrictive bariatric procedures. One Anastomosis Gastric Bypass is a simple and effective revisional procedure with less complications, shorter operative time and satisfactory weight loss.

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