










# Early and intermediate term outcomes after laparoscopic one-anastomosis gastric bypass for morbidly obese patients: a single center experience

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## ABSTRACT

**Objective:** To evaluate our outcomes of laparoscopic one-anastomosis gastric bypass (LOAGB) as a primary weight loss procedure. We evaluated the impact of biliary reflux by combination of upper endoscopy (UGIE), ambulatory pH metry, and ambulatory biliary reflux monitoring.

**Material and Methods:** We reviewed the data of patients who underwent LOAGB during the period between July 2015 till August 2018.

**Results:** Forty consecutive patients were included in the study. Thirty-seven patients (92.5%) had obesity related comorbidities. The median follow-up duration was 18 months (6-36 months). The 1-, 2-, and 3-years excess weight loss percentages were 53.1%, 60.4%, and 62.3%. At three years follow-up, complete remission of diabetes mellitus occurred in 7/7 patients (100%) and of hypertension in 4/7 patients (57.1%). Eighteen patients (45%) accepted to undergo UGIE with routine biopsies and evaluation of acidic and biliary reflux. All examined patients had negative acid reflux results according to ambulatory PH metry with median DeMeester score of 2 (0.3-8.7). According to ambulatory biliary reflux monitoring, 17/18 patients (94.1%) had positive result. Only 6/18 patients (33.3%) had symptoms of biliary reflux and had positive symptom index on bilimetric study. Regarding UGIE, all patients had just gastritis and reflux esophagitis with no evidence of gross mucosal changes. Pathological examination of all routine biopsies did not show any sign of faveolar hyperplasia, atypia or malignancy.

**Conclusion:** LOAGB is a safe and efficient bariatric procedure with acceptable morbidity rate. LOAGB is not associated with significant biliary reflux or pathological changes in the esophagogastric mucosa.

**Keywords:** One-anastomosis gastric bypass, morbid obesity, early outcomes

## INTRODUCTION

Emerging as a costly burden on the global healthcare system, obesity has currently attracted worldwide attention due to its continuously rising incidence (1). Obesity is commonly accompanied by a variety of comorbidities, especially type 2 diabetes mellitus (DM), hypertension, and obstructive sleep apnea syndrome (OSAS) (2).

Bariatric surgery has been increasingly performed as a promising intervention to improve long-term outcomes and quality of life in individuals with obesity (3,4). Bariatric surgical procedures are classified into restrictive, malabsorptive or both (5). One-anastomosis gastric bypass (OAGB), first reported by Rutledge, is a bariatric procedure which utilizes a divided vertical tube gastroplasty in conjunction with a loop intestinal bypass, which causes weight loss by both restriction and malabsorption (6).

OAGB has its own unique advantages compared to the gold standard Roux-en-Y gastric bypass (RYGB). Advantages of OAGB include shorter operation time, fewer sites for anastomotic leaks, shorter learning curve, easy reversibility with equivalent results in terms of weight loss and comorbidities resolution (7,8). However, its uptake by the bariatric community, even in Egypt where sleeve gastrectomy is more preferred, has been slow and controversial. Significant reflux of bile needing revisional operation, increased marginal ulceration and increased hazard of gastric malignancy because of chronic reflux of the bile are common controversies which

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are still unproven (7). Also, dyspepsia, gastric ulcers and anemia are the most common complication in the long run (9).

The current study was conducted to evaluate our center's experience of laparoscopic one-anastomosis gastric bypass (LOAGB) as a primary weight loss procedure for patients with morbid obesity. We aimed to evaluate the early and intermediate outcomes of LOAGB in terms of weight loss, quality of life and comorbidities resolution. Additionally, we evaluated the impact of biliary reflux on gastric tube and lower esophagus by combination of upper gastrointestinal endoscopy (UGIE), ambulatory pH metry, and ambulatory biliary reflux monitoring (BILITEC 2000).

## MATERIAL and METHODS

### Study Design

We reviewed the data of patients with morbid obesity who underwent LOAGB as a primary weight loss procedure during the period between July 2015 and August 2018. Patient data were reviewed from a prospectively maintained data base for all bariatric surgery patients. This study was approved by the local ethics committee and institutional review board.

Inclusion criteria were essentially the recommendations of the National Institutes of Health Consensus Development Panel of 1991 (10). Patients were eligible for inclusion in this study if they had morbid obesity with a body mass index (BMI)  $>40 \text{ kg/m}^2$  or BMI  $>35 \text{ kg/m}^2$  when associated with at least one comorbidity such as type II DM, hypertension, OSAS and hyperlipidemia. Included patients had history of failure of conservative measures for obesity, and the age was restricted to patients from 18 to 60 years old.

### Preoperative Evaluation

All patients were evaluated by a multidisciplinary surgical and medical team. Preoperative evaluation included detailed history, physical examination, detailed demographic data, and associated comorbidities evaluation. Detailed laboratory evaluation including hormonal profile was performed. Also, cardiopulmonary assessment was routinely performed. Abdominal ultrasonography and UGIE were routinely performed. Preoperative low molecular-weight heparin was used 12 hours preoperatively and at the night of the operation, then once daily till the patient was discharged in order to guard against deep venous thrombosis.

All patients were asked to sign an informed consent after meeting the surgeon and explaining all the possible benefits and risks of the procedure and stressing on the importance of regular follow up visits.

### Operative Technique

All surgeries were performed by the same bariatric surgery team. The patient was placed in reverse Trendelenberg position with split legs. The main surgeon stood between the patient's

legs, the main assistant stood to the left side of the patient, and the camera operator stood on the right side of the patient. Standard five trocars were utilized as described by Rutledge (6).

A long and narrow gastric tube is created parallel to the lesser curvature. The gastric tube was sleeved using laparoscopic linear staplers (Endo GIA™ Universal Straight 45-mm, blue cartridge) starting just distal to the incisura (distal to the crow's foot) perpendicular to the lesser curvature then upwards parallel to the lesser curvature (Endo GIA™ Universal Straight 60-mm, blue cartridges) till reaching the angle of His after insertion of gastric calibration tube (bougie 36 Fr).

A 150-200 cm jejunal loop (biliopancreatic limb) was measured from the ligament of Trietz and was anastomosed to the back of the gastric tube. The length of the biliopancreatic limb was tailored according to the patient preoperative BMI, age and presence or absence of comorbidities. Anastomosis was done in an antecolic Billroth II-type loop (side-to-side fashion) gastroenterostomy using linear stapler (Endo GIA™ Universal Straight 45-mm, blue cartridge). The opening for the stapler was closed using 3/0 absorbable suture material in a single continuous layer. We applied a hanging suture between the gastric tube and the biliopancreatic limb to be higher than the efferent limb. Leakage test by methylene blue was routinely performed to detect any leakage intraoperative. Abdominal drainage was inserted depending on the surgeon's preference.

### Postoperative Care and Follow Up

Patients were transferred to ward or intensive care unit (ICU) according to the anesthetic recommendations for close monitoring of the vital signs, urine output, abdominal drain. Patients were encouraged for early ambulation after surgery. Oral contrast study was routinely performed on the first postoperative day to assess gastric tube configuration and exclusion of leakage, obstruction or twist. Clear fluids were allowed after documenting a normal oral contrast study.

Patients were discharged if hemodynamically stable, pain free and in absence of post-operative complications with instructions to receive clear fluids for the first postoperative week, followed by soft diet for another three weeks. Subsequently, a long-term solid diet (hypo-caloric, protein-enriched) was maintained. Daily oral supplements of vitamins, minerals and monthly administration of intramuscular vitamin B12 were given to all patients for long term.

Patients were followed up regularly at the outpatient clinic every three months during the first year after surgery, then every six months afterwards or on patient's demand. Follow up visits included evaluation of weight loss progression, changes in associated comorbidities, development of postoperative complications, detailed laboratory evaluation to assess the nutritional status, and answered questionnaire evaluation the quality of

life using Bariatric Analysis and Reporting Outcome System (BAROS) questionnaire.

As biliary reflux is one of the most important points of criticism to this procedure, specific evaluation was conducted to assess the incidence of biliary reflux and its possible effect on mucosal lining of esophagus, gastric tube and the site of anastomosis. All patients were asked to perform ambulatory duodeno-gastric biliary reflux monitoring system using, BILITEC 2000 (Synectics Medical, Sweden), and ambulatory PH monitoring (Digtrapper MKIII, Synectics Medical, Sweden). In addition, we performed UGIE with routine biopsy from lower esophagus, gastric tube and the site of anastomosis to assess any mucosal changes due to biliary reflux.

### Study Definitions

Post-operative complications were recorded in a prospectively maintained database and graded according to Clavian-Dindo grading system (11). Changes of preoperative associated comorbidities were recorded according to standardization outcome reporting of metabolic and bariatric surgery (12).

Biliary reflux was assessed by subjective and objective methods. Subjectively, the patient was diagnosed with biliary reflux when complaining of hurt burn, epigastric pain and sore taste either denovo or aggravated after surgery. Objectively, the patient was diagnosed with biliary reflux when percentage of bilirubin by BILITEC 2000 was  $>0.14\%$  while Demester Score and total time reflux by PH metry was normal. Patient was diagnosed as symptomized biliary reflux when patient had positive symptom index with bilimetric study and endoscopic finding related to reflux esophagitis.

### Statistical Analysis

Shapiro-Wilk test was used to assess the normality of the data. Categorical variables were expressed as numbers and percentage and continuous variables were expressed as mean  $\pm$  standard deviation or median and range. Statistical analysis was performed by IBM-SPSS software for Windows (SPSS Inc., Chicago, IL, USA).

## RESULTS

During the study period, 40 patients underwent LOAGB as a primary weight loss procedure and were included in the study.

### Patients' Demographics

Preoperative demographic data are shown in Table 1. Median age of the patients was 44.5 years (16-60). Most of the patients were females (77.5%). Thirty-seven patients (92.5%) had obesity related comorbidities. All preoperative laboratory studies including hormonal profiles were within the normal range for all patients.

### Operative Data

Operative data of the study patients are shown in Table 2. Laparoscopic approach was utilized in all patients. Only one case

(2.5%) required open conversion due to splenic injury. Stapling failure during creation of the gastric tube occurred in one case (2.5%), and leakage on methylene blue test occurred in another case (2.5%). Both required enforcement of the staple line with absorbable sutures.

### Postoperative Data

Median length of hospital stay was four days (2-7). All patients had a smooth postoperative course and oral clear fluids were started on the first postoperative day. Only one patient (2.5%) developed intra-abdominal bleeding on the same day of the operation. Laparoscopic exploration was done and bleeding from the staple line was controlled by metallic clips. On 5<sup>th</sup> postoperative day, this patient developed persistent fever and pelvic tenderness. Follow up abdominal ultrasound revealed an infected abdominal hematoma and ultrasound guided tube drainage was done. It should be noted that none of the study patients developed postoperative leakage or life-threatening morbidities.

### Early and Intermediate Follow Up

Median follow-up duration was 18 months (6-36 months). Some patients were lost from follow up either due to travelling abroad or difficulty to communicate due to change of phone number or address. At six months postoperatively, 34/40 patients (85%) were available for follow up. At one year postoperatively, 34/40 patients (85%) were available for follow up. At 18 months postoperatively, 25/32 patients (78.1%) were available for follow up. At two years postoperatively, 18/21 patients (85.7%) were available for follow up. Similarly, at three years postoperatively, 18/21 patients (85.7%) were available for follow up.

### \* Weight Loss

Changes of body weight, BMI, excess weight loss (EWL), and excess BMI loss (EBMIL) are shown in Table 3 and Figure 1.

\* Changes in Obesity Related Comorbidities

### Diabetes Mellitus

Seventeen patients (42.5%) of the study patients had DM. Changes in DM in the study patients is shown in Table 4. At 1 year of postoperative follow up, complete remission of DM was achieved by 8/13 patients (61.5%) and improvement of DM was achieved by 4/13 patients (30.8%). At two years of postoperative follow up, complete remission of DM was achieved in 6/7 patients (85.7%) and improvement of DM was achieved by 1/7 patients (14.3%). At three years of postoperative follow up, complete remission of DM was achieved in 7/7 patients (100%).

It should be noted that only one patient had preoperative type I DM. This patient had unchanged status of DM after one year of postoperative follow up.

**Table 1.** Demographic data of the study patients

Variables	Data
Age (years)	44.5 (18-60)
Sex	
Male	9 (22.5%)
Female	31 (77.5%)
Weight (kg)	144.5 (1.06-250)
Height (m)	1.65 (1.45-2)
Body mass index (kg/m <sup>2</sup> )	54.1 (41.4-84.4)
Previous attempts to weight loss	
• No	3 (7.5%)
• Diet control	36 (90%)
• Intra-gastric balloon	1 (2.5%)
Comorbidities	
• Diabetes mellitus	17 (42.5%)
◦ Type I	1 (2.5%)
◦ Type II	16 (40%)
• Systemic hypertension	15 (37.5%)
• Obstructive sleep apnea	25 (62.5%)
• Hyperlipidaemia	10 (25%)
• Osteoarthritis	37 (92.5%)
• Reflux esophagitis	14 (35%)
Associated gall bladder stones	5 (12.5%)
Previous abdominal surgery	46 (65%)
Surgery type	
• Cholecystectomy	4 (10%)
• Lower abdominal operations	22 (55%)
Upper gastrointestinal endoscopy	
• Done	40 (100%)
Upper endoscopy finding	
• Free	9 (22.5%)
• Reflux esophagitis	2 (5%)
• Gastritis	17 (42.5%)
• Reflux esophagitis and gastritis	12 (30%)

**Table 2.** Operative data of the study cases

Variables	Data
Operation time (minutes)	120 (60-360)
Blood loss (ml)	100 (40-700)
Blood transfusion	1 (2.5%)
Length of bypassed small bowel	200 (150-200)
• 150 cm	5 (12.5%)
• 180 cm	11 (27.5%)
• 200 cm	24 (60%)
Intraoperative complications	3 (7.5%)
Complications types:	
• Stapling failure	1 (2.5%)
• Leak on methylene blue test	1 (2.5%)
• Injury to the spleen	1 (2.5%)

**Table 3.** Changes in body weight, body mass index, excess weight loss and excess body mass index loss during follow up period

	6 months	12 months	18 months	24 months	36 months
Weight (kg)	117 (85-195)	102.5 (75-180)	97 (75-147)	93 (71-140)	90 (68-120)
Body mass index (kg/m <sup>2</sup> )	42.6 (33.2-72.2)	37.3 (30.1-66.1)	34.8 (28.3-59.6)	35.1 (30.3-56.8)	34.7 (29.1-42.5)
Excess weight loss (%)	35.3 (19.2-53.3)	53.1 (25-72.1)	59.5 (32.3-82.9)	60.4 (41.6-75.1)	62.3 (42.5-77.8)
Excess body mass index loss (%)	38.4 (20.5-61.1)	59.3 (27.8-79.8)	66.9 (35.9-88.2)	67.2 (46.3-83.9)	68.3 (48.5-85.6)



**Figure 1.** Changes in weight loss parameters during the follow up period. **A.** Changes in body weight (kg). **B.** Changes in body mass index (kg/m<sup>2</sup>). **C.** Changes in excess weight loss (%). **D.** Changes in excess body mass index loss (%).

**Hypertension**

Fifteen patients (37.5%) of the study patients had hypertension. Changes in hypertension in the study patients are shown in Table 4. At one year of postoperative follow up, complete remission of hypertension was achieved by 6/11 patients (54.5%) and improvement of hypertension was achieved by 4/11 patients (36.4%). At 18 months of postoperative follow up, one patient (1/9-11.1%) showed recurrence of hypertension after complete remission and required re-use of antihypertensive medications.

At two years of postoperative follow up, complete remission of hypertension was achieved in 3/7 patients (42.9%) and improvement of hypertension was achieved by 3/7 patients (42.9%). At three years of postoperative follow up, complete remission of hypertension was achieved in 4/7 patients (57.1%), and improvement of hypertension was achieved by 2/7 patients (28.6%).

**Obstructive Sleep Apnea Syndrome and Osteoarthritis**

In our study, we depended on a subjective method to evaluate the improvement of OSAS and osteoarthritis symptoms. All

**Table 4.** Changes in diabetes mellitus and hypertension status during the follow up period

	6 months	12 months	18 months	24 months	36 months
Change in Diabetes Mellitus Status During Follow-up (n= 17)					
Patients number	17/17 (100%)	17/17 (100%)	13/17 (76.5%)	10/17 (58.8%)	10/17 (58.8%)
Patients available on follow up	13/17 (76.5%)	13/17 (76.5%)	9/13 (69.2%)	7/10 (70%)	7/10 (70%)
Complete remission	6 (46.2%)	8 (61.5%)	6 (66.7%)	6 (85.7%)	7 (100%)
Improvement	6 (46.2%)	4 (30.8%)	3 (33.3%)	1 (14.3%)	0
Unchanged	1 (7.7%)	1 (7.1%)	0	0	0
Change in Hypertension Status During Follow-up (n= 15)					
Patients number	15/15 (100%)	15/15 (100%)	13/15 (86.7%)	10/15 (66.7%)	10/15 (66.7%)
Patients available on follow up	11/15 (73.3%)	11/15 (73.3%)	9/13 (69.2%)	7/10 (70%)	7/10 (70%)
Complete remission	1 (9.1%)	6 (54.5%)	4 (44.4%)	3 (42.9%)	4 (57.1%)
Improvement	9 (81.8%)	4 (36.4%)	3 (33.4%)	3 (42.9%)	2 (28.6%)
Unchanged	1 (9.1%)	1 (9.1%)	1 (11.1%)	0	0
Recurrence	0	0	1 (11.1%)	1 (14.3%)	1 (14.3%)

patients (100%) had improvement of OSAS symptoms after 12 months follow up, while 28 patients (90.3 %) had improvement of osteoarthritis symptoms after 12 months follow up. Only three patients (9.7%) had unchanged status of osteoarthritis symptoms. These patients had previous history of knee and hip arthropathy and were planned for knee and hip joint replacement.

### Reflux Esophagitis

Eighteen patients (45%) accepted to undergo UGIE with biopsy and evaluation of acidic and biliary reflux. Thirteen patients (32.5%) refused to undergo this evaluation protocol as they did not complain from any reflux symptoms, eight patients (15%) were missed follow up, and one patient (2.5%) underwent undoing of LOAGB at the time of the study. Results of endoscopic evaluation, ambulatory PH monitoring and biliary reflux monitoring (BILITEC 2000) are shown in Table 5.

According to ambulatory PH recorder, all examined patients had negative results. The median DeMeester score was 2 (0.3-8.7), so, there was no acidic reflux esophagitis in all examined patients. Nevertheless, according to ambulatory biliary reflux monitoring system, 17/18 patients (94.1%) had positive result and only 1/18 patient (5.9%) had negative result. Only 6/18 patients (33.3%) had symptoms of biliary reflux and had positive symptom index on bilimetric study Figure 2.

Regarding UGIE, all patients had just gastritis and reflux esophagitis with no evidence of gross changes or any signs of malignancy Figure 3. Also, pathological examination of all routine biopsies did not show any sign of foveolar hyperplasia, atypia or malignancy Figure 4.

### Quality of Life

Thirty-four patients, who were approached at the 12<sup>th</sup> month postoperatively, were asked to fill a quality of life questionnaire (BAROS Score). The commonest score was "very good", which was found in 18/34 patients (55%). Results of BAROS quality of life questionnaire are shown in Table 6.

### Late Complications

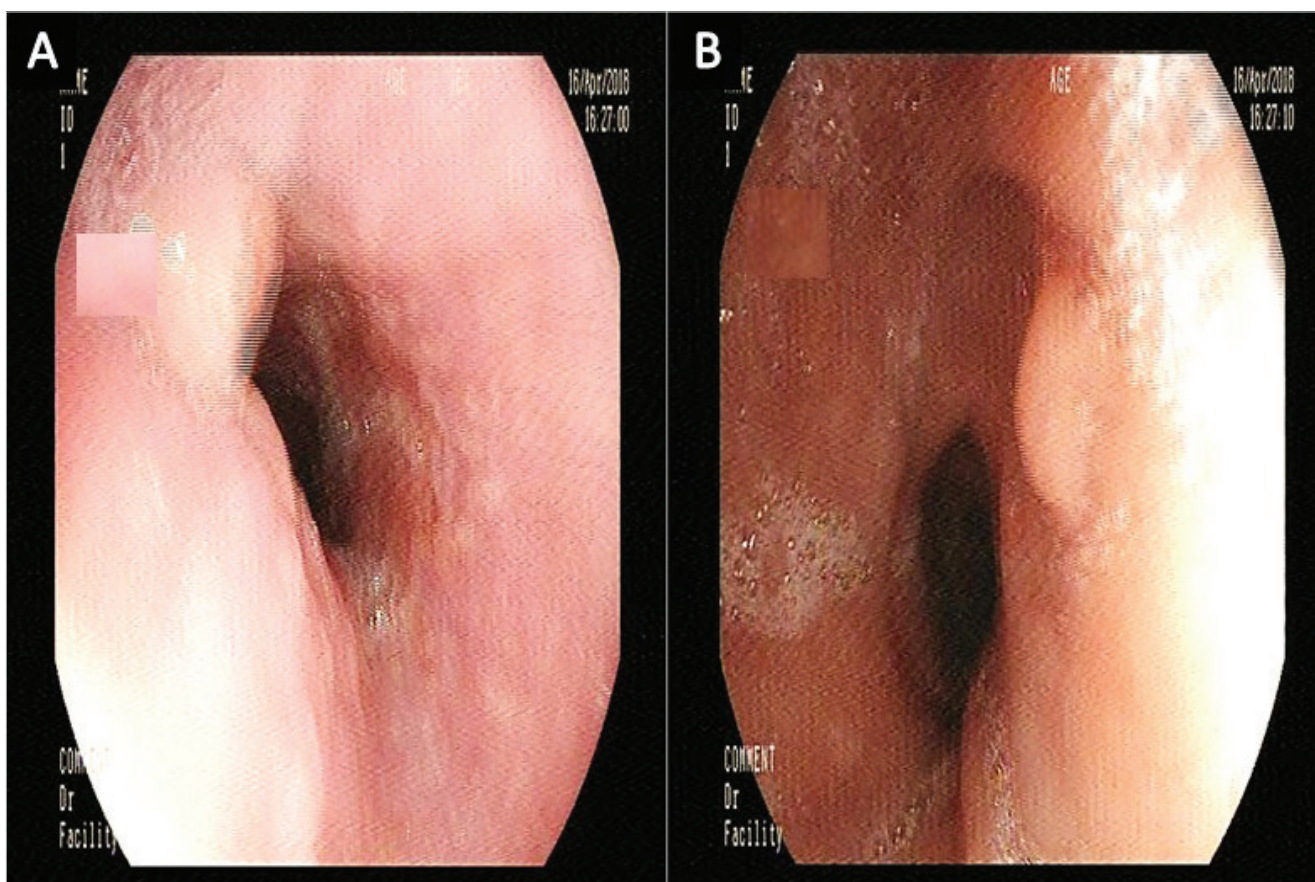
After a median follow up period of 18 months (6-36 months), 12/40 patients (30%) experienced late postoperative complications. Malnutrition, in the form of protein malnutrition, occurred in 2 patients (5%). One patient was managed conservatively by strict nutritional support and the other patient required undoing of LOAGB. Two patients (5%) presented with iron deficiency anemia and were managed conservatively by oral iron therapy.

Biliary reflux, as defined by combined positive symptoms and Bilitek results, occurred in six patients (15%). All patients were managed by medical therapy with proton pump inhibitors, prokinetics and ursodeoxycholic acid. No patients required any revisional surgery for biliary reflux.

Marginal ulcer occurred in one patient (2.5%). This patient had long history of analgesics intake for chronic lumbar disc prolapse. She was complaining from epigastric pain and diagnosed by UGIE at 12 months postoperatively. She was managed medically with proton pump inhibitors.

Failure of weight loss occurred in one patient (2.5%) at 12 months postoperatively. Investigation revealed the presence of gastro-gastric fistula. The patient underwent completion of LOAGB and division of the gastro-gastric fistula.

<b>Table 5.</b> Results of BILITEC study, ambulatory PH monitoring, and upper gastrointestinal endoscopy of the study patients	
<b>Variables</b>	<b>Data</b>
Ambulatory biliary reflux monitoring (BILITEC 2000)	
Bilirubin percentage	70.2 (0.5-90%)
Bilitek symptom index (%)	
o 0	12 (66.6%)
o 40	1 (5.55%)
o 50	1 (5.55%)
o 100	4 (22.22%)
Bilitek result	
o Positive	17 (94.1%)
o Negative	1 (5.9%)
Ambulatory PH monitoring	
Total reflux	
o 0	1 (5.55%)
o 0.1	13 (72.2%)
o 0.2	3 (16.66%)
o 0.3	1 (5.55%)
DeMeester score	2 (0.3-8.7)
PH metry symptom index (%)	
o 0	18 (100%)
PH metry result	
o Positive	0
o Negative	18 (100%)
Upper Gastrointestinal Endoscopy	
Esophagus	
o Normal	2 (5%)
o Hyperemia	7 (17.5%)
o Grade I reflux	3 (7.5%)
o Grade II reflux	5 (12.5%)
o Grade III reflux	1 (5.6%)
Cardia	
o Normal	6 (33.3%)
o Wide	9 (50%)
o Wide with small sliding hiatus hernia	3 (16.7%)
Gastric tube	
o Mild gastritis	12 (66.7%)
o Severe gastritis	6 (33.3%)
Gastro-jejunosotomy stoma	
o Normal	9 (50%)
o Hyperemia	9 (50%)
Pathological Results of Endoscopic Biopsies	
Esophageal biopsy	
o Normal	4 (22.2%)
o Inflammatory	14 (77.8%)
Gastric pouch biopsy	
o Normal	3 (16.7%)
o Inflammatory	15 (83.3%)
Stoma biopsy	
o Normal	4 (22.2%)
o Inflammatory	14 (77.8%)



**Figure 2.** Line Graph from result of ambulatory PH monitoring and ambulatory biliary reflux monitoring (BILITEC 2000) revealing positive symptoms index (arrows) in alkaline PH and combined with rising of percentage of bilirubin in distal esophagus.

## DISCUSSION

OAGB was first described by Rutledge as a simple, safe, and easy procedure with short operative time (6). Studies have shown that MGB is effective in accomplishing adequate weight reduction and improvement of obesity related comorbidities which are comparable to the results of RYGB. Moreover, MGB is associated with shorter learning curve, shorter operation time, less development of major surgical complications, and improvement of the quality of life of patients (7,8,13-15).

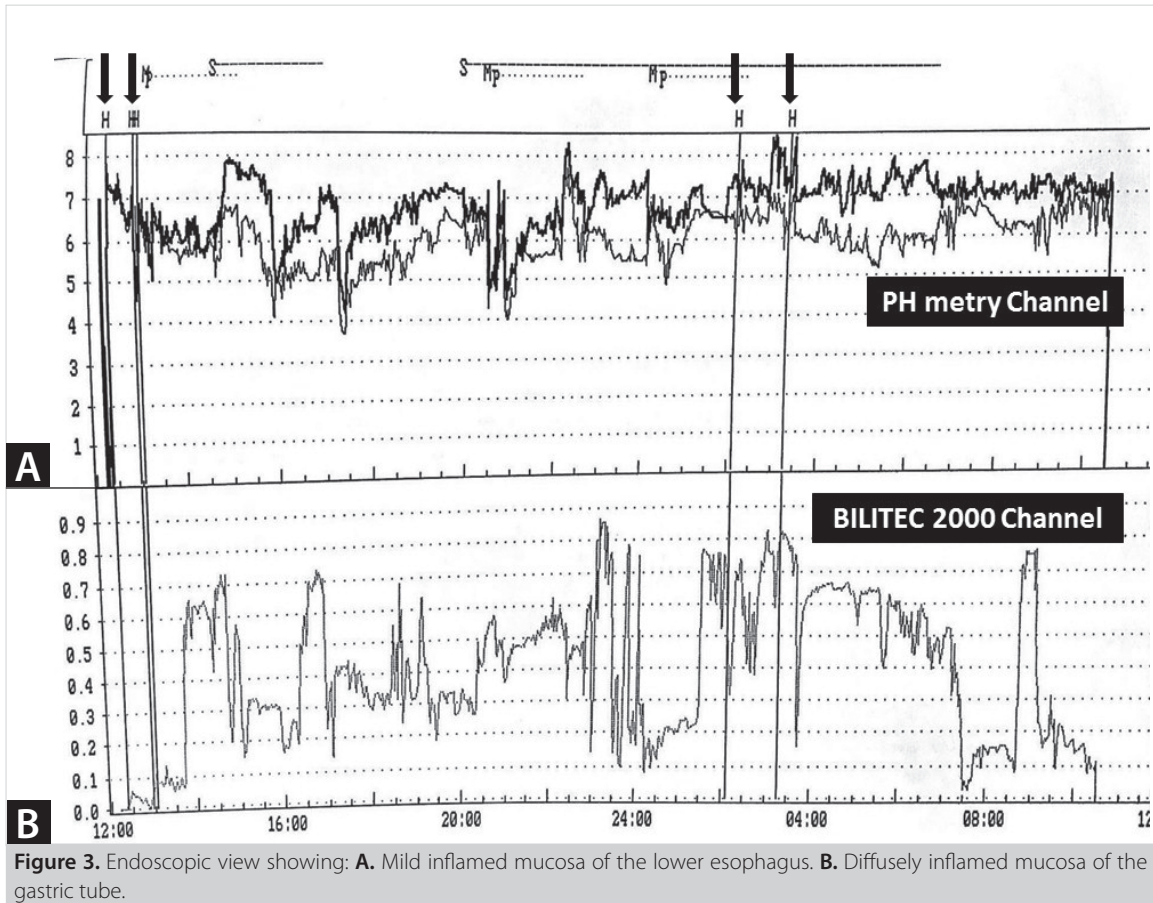
In this study, we evaluated the short and intermediate term outcomes of our initial experience of LOAGB as a primary weight loss procedure for patients with morbid obesity. LOAGB is not a commonly selected procedure among our morbidly obese patients who prefer to undergo a laparoscopic sleeve gastrectomy or its modifications. This is attributed to the patients' worries regarding failure of achievement of satisfactory weight loss and the development of severe biliary reflux. In our surgical practice, we followed the original technique proposed by Rutledge for LOAGB (6). We used to measure the length of the bypassed limb from duodeno-jejunal junction and its length varied from 150 cm to 200 cm according to patient age, BMI and associated co-

morbidities. However, the length of the bypassed limb is greatly heterogenous between different studies (16,17). Median operative time in our study was 120 minutes, which is relatively longer than operation time reported by other studies (6,16,18,19). This could be explained by the early experience of our team in performing LOAGB. With accumulation of surgical experience regarding LOAGB, the operation time became shorter. The operation time decreased to a median of 90 minutes in the last 10 cases of the current series.

Previous studies regarding LOAGB have reported postoperative morbidity rate ranging between 5.9 to 13.5%, which is less than reported for RYGB (6,8,19,20). In our study, only one patient (2.5%) developed postoperative morbidity in the form of internal hemorrhage requiring re-operation to control bleeding from staple line. The lower incidence of morbidity rate in our study can be attributed to the small number of cases included in our study. Also, we included cases who only had a primary weight loss procedure while revisional bariatric cases were excluded.

Leakage following bariatric procedures remains the most serious complication as it is associated with high incidence of





**Figure 3.** Endoscopic view showing: **A.** Mild inflamed mucosa of the lower esophagus. **B.** Diffusely inflamed mucosa of the gastric tube.

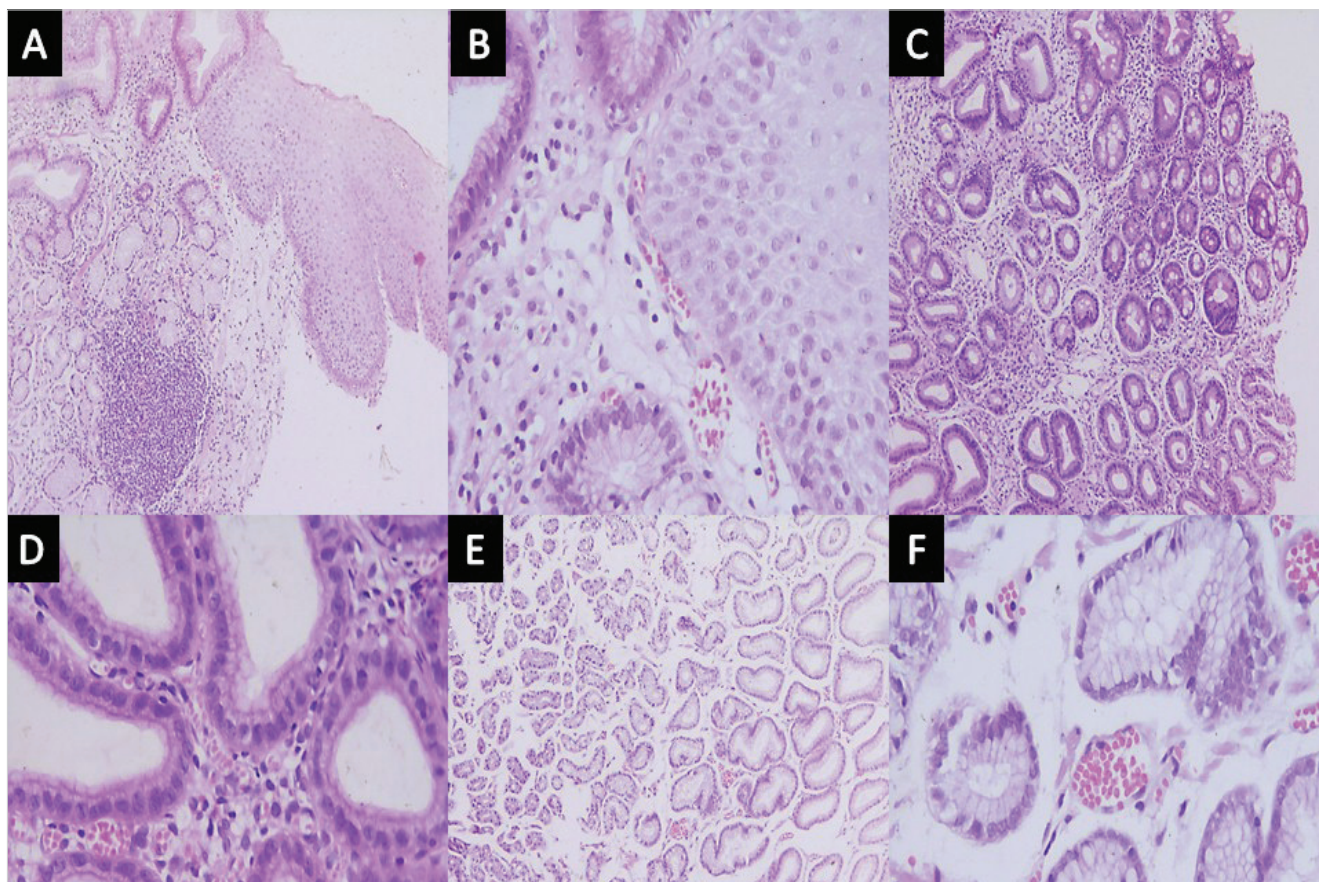
postoperative mortality (21). Incidence of leakage after LOAGB varies between 0.1-1.08%, which is lower when compared to RYGB and sleeve gastrectomy. It can occur from gastro-jejunostomy, gastric pouch or excluded stomach (6,17,19). In the current study we did not experience any cases of postoperative leakage.

LOAGB offers effective and long-term weight loss results with almost 75% of EWL at the first year postoperatively (6,22,23). Also, it provides comparable EWL to RYGB (72.9% vs 60.1%) (8). In the current study, LOAGB achieved good weight loss in most patients, with 92.5% of patients achieving more than 50% of EWL at their first year. However, the percentage of EWL at first year was only 53.1%, which could be attributed to our initial experience with the procedure so we did not go for measurement of the whole small bowel length. Thus, the exact percentage of the bypassed bowel was uncertain. In addition, we selected LOAGB for patients with relatively high preoperative BMI. Median preoperative BMI among our patients was 54.1 kg/m<sup>2</sup> (41.4-84.4 kg/m<sup>2</sup>).

Bariatric surgery is effective in not only weight loss but also remission of obesity associated comorbidities such as DM and hypertension (24). LOAGB alters the gastrointestinal hormonal

status, and results in improvement of most of the associated comorbidities, especially DM, and this considered one of the most attractive advantages reported for LOAGB. Complete remission of type II DM ranges between 83% to 90% as reported in large LOAGB series (6,8,18,19,20,23,25,26). In the current study, complete remission rate of type II DM was 85.7% after two years of follow-up and reached 100% after three years of follow up. Similarly, systemic hypertension remission. Previous series of LOAGB have shown remission rate of hypertension after LOAGB ranging between 29% to 91.6% (18-20,23). In the current study, remission rate of hypertension was 57.1%, which is very similar to the series reported by Chevallier et al. (20).

Biliary reflux remains the most controversial problem of LOAGB with increased hazard of esophageal or gastric mucosal changes (22). In the current study, we evaluated the impact of biliary reflux on gastric tube and lower esophagus by combination of UGIE, ambulatory pH metry, and ambulatory biliary reflux monitoring (BILITEC 2000). Six patients (15%) in our study experienced bile reflux based on combinations of patient symptoms, results of bilimetric studies, and UGIE. Musella et al. had 28 patients (4%) with biliary reflux but only four patients required revisional surgery (25). Chevallier et al. had lower rate of biliary



**Figure 4.** Photomicrograph of routine endoscopic biopsies: **A, B.** Biopsies from cardio-esophageal junction showing mild reflux esophagitis. **A.** The esophageal mucosa showing mild basal cell hyperplasia with elongation of lamina propria papillae. The lamina shows lymphoplasmacytic infiltrate and lymphoid aggregate (H&E  $\times 200$ ). **B.** The lamina shows lymphoplasmacytic infiltrate, mild edema and congested capillaries (H&E  $\times 400$ ). **C, D.** Biopsies from the gastric tube showing mild superficial gastritis. **C.** The lamina shows mild to moderate mixed inflammatory infiltrate and congested capillaries (H&E  $\times 200$ ). **D.** The lamina shows mild to moderate mixed lymphoplasmacytic infiltrate with edema and congested capillaries (H&E  $\times 400$ ). **E, F.** Biopsies from the gastro-jejunosomy stoma showing mild inflammatory changes. **E.** Multiple snips of gastric mucosa with lamina showing mild mixed inflammatory infiltrate and congested capillaries (H&E  $\times 200$ ). **F.** The lamina shows mild lymphoplasmacytic infiltrate with edema and congested capillaries (H&E  $\times 400$ ).

**Table 6.** BAROS quality of life score of the study patients at 12 months postoperatively

BAROS Score	Number of patients (n= 34)
Fair	4 (11.7%)
Good	9 (26.5 %)
Very good	18 (53%)
Excellent	3 (8.8 %)

reflux (0.7%) but all of their patients required conversion to RYGB (20). On the other hand, Carbajo et al. had no incidence of biliary reflux in their study and they explained this by their specific technique for one anastomosis gastric bypass which differs from LOAGB by its anti-reflux mechanism (26). The incidence of biliary reflux in the current study is relatively higher than reported by other series, which could be explained by our interest to document biliary reflux by both subjective and objective meth-

ods. Furthermore, we did not combine our technique with any anti-reflux procedures. It should be noted that all of our cases had mild degree of biliary reflux and were managed medically without the need for any revisional surgeries.

Several late postoperative complications have been reported after LOAGB including marginal ulcers, failure of weight loss and severe malnutrition. Anastomotic marginal ulcers are one of the most dangerous complications after bypass surgeries. Incidence

of marginal ulcer with LOAGB is lower than RYGB as bile reflux is buffering the acid ulcerating action (20). Previous studies regarding LOAGB have reported incidence ranging between 0.2% and 4% (6,18-20). In the current study, only one patient (2.5%) had marginal ulcer and managed medically. This patient had long history of NSAIDs due to chronic vertebral disc prolapse.

Failure of weight loss is defined by achieving EWL <50% at the first year post-operatively (27). This is mostly associated with the early learning curve, and is due to pouch size and bypassed loop length (20). In the current study, only one patient (2.5%) had failed to lose >50% of EWL due to the presence of gastro-gastric fistula. The patient underwent laparoscopic completion of LOAGB and division of fistula. On the other hand, malnutrition is one of the serious complications after LOAGB. The length of bypassed jejunal loop and its malabsorption effect has always been claimed to be the cause of malnutrition and excessive weight loss after LOAGB (28). Incidence of malnutrition after LOAGB varied from one surgeon to other and their management also varied (25). Reported incidence of malnutrition after LOAGB varies between 0.1% to 0.2% (6,18-20). All reported cases experienced severe malnutrition and required revisional surgery. In the current study, two patients (5%) were complicated with malnutrition. One patient (2.5%) required undoing of LOAGB, while the other (2.5%) was managed conservatively with strict nutritional program with dietician. The higher incidence of malnutrition in our study is attributed to many factors like rough method of measurement of the bypassed limb percentage, the socioeconomic status of the patients in our country and their strict compliance with postoperative multivitamins and nutritional supplements.

Our study has several limitations including that it is a retrospective and single center experience. Also, our study is limited by the small number of patients included but as explained before, this is our initial experience for a non-popular procedure among our obesity patients. Final limitation is the short duration of follow up of our patients.

## CONCLUSION

In conclusion, LOAGB is a safe and efficient bariatric procedure with acceptable morbidity rate. LOAGB is not associated with a significant incidence of postoperative biliary reflux, or pathological changes in the esophagogastric mucosa. A future prospective comparative study including a larger number of patients is ongoing which will help to elucidate the merits and drawbacks of LOAGB.

**Ethics Committee Approval:** The approval for this study was obtained from Mansoura University Institutional Research Board (Proposal No: MS.18.03.82, Date: 25.03.2018).

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## ORJİNAL ÇALIŞMA-ÖZET

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### Morbid obez hastalarda laparoskopik tek anastomoz gastrik baypas sonrası erken ve orta dönem sonuçları: Tek merkez deneyimi

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#### ÖZET

**Giriş ve Amaç:** Bu çalışmada, birincil kilo verme işlemi olarak laparoskopik tek anastomozlu gastrik baypas (mini gastrik baypas) (LTAGB) sonuçlarımızı değerlendirmeyi amaçladık. Üst endoskopi (ÜGSE), ambulatuvar pH metre ve ambulatuvar biliyer reflü takibi kombinasyonu ile biliyer reflü etkisini değerlendirdik.

**Gereç ve Yöntem:** Temmuz 2015 ve Ağustos 2018 arasında LTAGB cerrahisi geçiren hastaların verileri incelendi.

**Bulgular:** Ardışık 40 hasta çalışmaya dahil edildi. Otuz yedi (%92,5) hastanın obezite ilişkili komorbiditesi mevcuttu. Ortanca takip süresi 18 aydı (6-36 ay). Birinci, ikinci ve üçüncü yıl fazlalık olan kilo kaybı yüzdeleri sırasıyla %53,1, %60,4 ve %62,3 idi. Üç yıllık takip süresince 7/7 hastada (%100) diabetes mellitus tamamen düzelerken hipertansiyon ise 4/7 hastada (%57,1) düzeldi. Rutin biyopsi ve asidik ve biliyer reflü ile birlikte on 18 hasta (%45) ÜGSE yaptırmayı da kabul etti. Ambulatuvar pH metre ve ortanca 2'lik DeMeester skoru (0,3-8,7) ile tüm incelenen hastalarda negatif asit reflü sonuçları elde edildi. Ambulatuvar biliyer reflü takibine göre, 17/18 hastada (%94,1) pozitif sonuç tespit edildi. Sadece 6/18 (%33,3) hastada biliyer reflü semptomları ve bilimetric analizde pozitif semptom indeksi mevcuttu. ÜGSE açısından gros mukozal değişiklik gösteren herhangi bir belirti olmadan tüm hastalarda sadece gastrit ve reflü özofajit vardı. Rutin biyopsilerin hepsine uygulanan patolojik incelemede foveolar hiperplazi, atipi veya malignite belirtisi yoktu.

**Sonuç:** LTAGB, kabul edilebilir mortalite oranıyla güvenilir ve etkin bir bariyatrik işlemdir. LTAGB ciddi biliyer reflü veya özofagogastrik mukozada patolojik değişiklikler ile ilişkili değildir.

**Anahtar Kelimeler:** Tek anastomozlu gastrik baypas, morbid obezite, erken sonuçlar, biliyer reflü

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