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Laparoscopic Gastric Fundectomy with Greater Curvature Plication: A Feasibility Study for Obese Patients

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ABSTRACT

Background: Obesity is a worldwide epidemic. Bariatric surgery is a curative management intervention. However, it is not devoid of comorbidities. Different modalities were continuously developed to increase effectiveness and safety.

The aim of the work: To evaluate the feasibility of laparoscopic gastric fundectomy with greater curvature plication of the remaining part of the stomach for the management of morbid obesity.

Patients and Methods: Twenty-five patients with morbid obesity were included. All patients were preoperatively assessed through full history taking and clinical examination. In addition, all underwent routine laboratory and radiological investigations to establish their fitness for surgery. After surgery, patients were followed up after one week, 1, 3, 6 months, one and two years for assessment of effective weight loss and comorbidities [e.g., bleeding, gastric leak, stricture, etc.]. Success was defined as the ability to achieve 40% or more of estimated body weight loss [EBWL].

Results: Males represented 28%. The most common age group was 35 to 45 years [76.0%]. The married patients were 56%; and childhood onset of obesity was [60.0%]. Obesity-related complications were in the form of diabetes, hypertension, arthritis, and sleep apnea syndrome in 32.0%, 16.0%, 28.0%, and 8.0%, respectively. The complications included seroma, port site infection, nausea, persistent vomiting, postoperative bleeding, and cholelithiasis among 8%, 4%, 8%, 16%, and 4%, respectively. Finally, there was a progressive increase of estimated body weight loss from the first postoperative week until the end of the second year of follow-up. In addition, there was an improvement of associated comorbidities at the end of the follow-up period. The failure rate was [8%]. No mortality occurred during the follow-up period.

Conclusion: Laparoscopic gastric fundectomy with greater curvature plication of the remaining part of the stomach in morbid obesity is an effective and relatively safe procedure, with promising results.

Keywords: Fundectomy; Laparascopic; Greater curvature plication; Obesity; Morbid.

INTRODUCTION

Obesity become a worldwide epidemic. This is attributable to change in dietary habits [e.g., fast unhealthy foods] and sedentary lifestyles. It affects more than 20% of adults [10.8% of men [266 million] and 14.9% of women [375 million] worldwide in 2014] and 20.1% of children aged 6 years [1-3].

Obesity is associated with excess body fat accumulation, which could be associated with an adverse health effect, with potential reduction of life expectancy and/or increased health comorbidities. Body mass index [BMI], is a measurement used to recognize and classify overweight and obesity. Accordingly, overweight [pre-obese] is defined as BMI between 25 and 30 kg/m^2, and obese when it is greater than 30 kg/m^2 [4].

Bariatric Surgery was introduced in the last 60 years. However, it did not gain wide acceptance except recently. Its benefits had not been restricted to weight loss, but it usually associated with benefits for every single organ or function. Notably, patients with diabetes mellitus, hypertension, hyperlipidemia, chronic obstructive pulmonary disease [COPD], obstructive sleep apnea, arthritis and gastroesophageal reflux disease are improved with bariatric surgery. In addition, different studies appreciated the effect of bariatric surgery for renal, cardiac and mental functions [5-8].

Bariatric surgeries could be malabsorptive as biliopancreatic diversion [BPD], or restrictive innervations, such as vertical banded gastroplasty [VBG], Laparoscopic sleeve gastrectomy [LSG], Laparoscopic greater curvature plication [LGCP]. Each procedure has its advantages and disadvantages. Thus, the selection of the bariatric procedure should be individualized and selected with great caution [9-11].

Greater curvature plication [GCP] is viewed as a restrictive procedure that helps prevent complications linked to the permanent placement of an adjustable gastric band, while also reducing the risk of leaks associated with sleeve gastrectomy. It was initially introduced in 2007. This technique involves cutting the short gastric vessels but does not require stapling or removal of tissue, which may offer some benefits over sleeve gastrectomy [12, 13].

To avoid possible complications associated with bariatric surgery, we introduced gastric fundectomy with Greater Curvature Plication. Initial experience with open procedure is under publications, and here we presented our initial experience with laparoscopic procedure.

The aim of this work is to assess the feasibility of laparoscopic gastric fundectomy with grater curvature plication of the remaining part of the stomach for management of morbid obesity, its safety and effect on the weight loss.

PATIENTS AND METHODS

This study included 25 patients with morbid obesity, who were scheduled for laparoscopic gastric fundectomy with greater curvature plication of the remaining part of the stomach. It had been carried out at Damietta University Hospital [Al-Azhar University] from October 2017 to October 2019. We included patients aged 20- 45 years old, who had BMI greater than or equal to 35 kg/m^2, non-sweet eaters, with no endocrinal disturbances, who failed other measures to lose weight, who had no gastroesophageal reflux disease [GERD] or hiatus hernia, and with no previous upper gastrointestinal [GIT] surgery. On the other side, we excluded patients younger than 20 years or older than 45 years of age, who unfit for anesthesia and surgery, sweet eaters, with previous upper GIT surgeries, and who had unmanageable psychological disturbances.

Ethical considerations: Consent was obtained from all patients after explanation of the procedure and expected complications. Approval by Ethical and Medical Committee faculty of medicine, Al-Azhar University [Damietta] was obtained.

All eligible subjects were submitted to:

1. Preoperative assessment [full medical and surgical history taking, weight and height to calculate body mass index [BMI], psychological assessment, assessment of dietary habits of patients and previous trials of weight reduction, and evaluation of associated co-morbidity and treatment medications used [diabetes, hypertension, arthritis and obstructive sleep apnea syndrome]].

2. Laboratory investigations included complete blood picture [CBC], liver function tests [SGPT-SGOT-S. bilirubin- S. albumin], coagulation profile [bleeding time, partial thromboplastin time and international normalization ratio], arterial blood gases [ABG], fasting and post prandial blood glucose, renal function tests [serum creatinine and blood urea], profile functions of thyroid gland, serum cortisol. In addition, imaging studies included

chest X-ray, abdominal ultrasonography and duplex ultrasound to both lower limbs, and upper GIT Endoscopy.

Operative details: Under general anesthesia, patients were positioned in a reverse Trendelenburg position, angled 30° upwards. The camera operator stood on the patient's right side, while the assistant was on the left. The surgeon positioned himself between the patient's legs. A prophylactic dose of one gram of a third-generation cephalosporin was administered. After establishing pneumoperitoneum, five ports were inserted: one 10 mm optical port above the umbilicus, one 12 mm port in the right midclavicular line above the optical port level, one 5 mm port in the left midclavicular line above the optical port level, one 5 mm port below the xiphoid for liver retraction, and one 5 mm port in the left anterior axillary line. The blood supply to the greater curvature of the stomach was divided starting 4-6 cm from the pylorus and continuing upward to the angle of His using a vessel sealing device. Occasionally, posterior gastric adhesions were also cut to ensure optimal mobility [Figure 1].

Fundectomy: Planning of the fundic part which was excised, then fundectomy was performed using a linear stapler with about three sequential blue cartridges. Good hemostasis was obtained with medium sized clips [figure 2].

Greater curvature plication: After removal of the fundus, 32-fr calibrating bougie inserted against lesser curvature to the pylorus then the gastric plication was performed by folding the greater curvature, utilizing a first row of interrupted non-absorbable 0 sutures in a seromuscular fashion to stay clear of gastric acid [Figure 3]. The spacing between the sutures ranged from 1.0 to 1.5 cm. A second row of running non-absorbable 0 sutures was added for reinforcement, ensuring the plication was secure and preventing any herniation between the sutures [Figure 4]. A leak test was conducted by applying pressure on the pylorus and injecting 100 ml of methylene blue through the bougie. One drain was placed in the surgical area, and the port sites were closed with sutures.

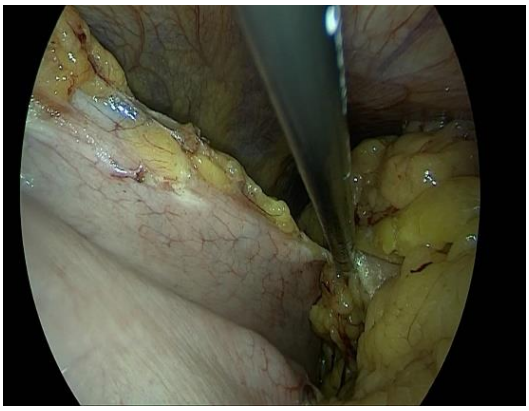

Figure [1]: Devascularization of the greater curvature

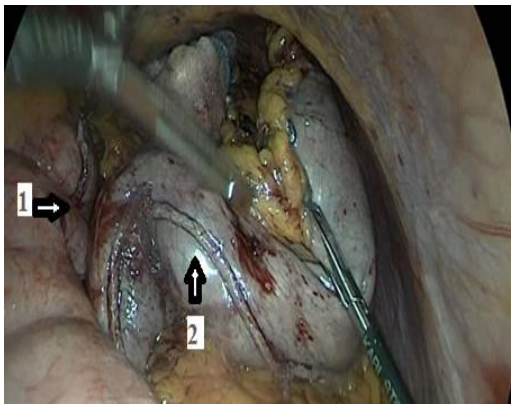

Figure [2]: The appearance of stomach after fundectomy; [1] Stapler line of fundectomy. [2] Removed fundus.

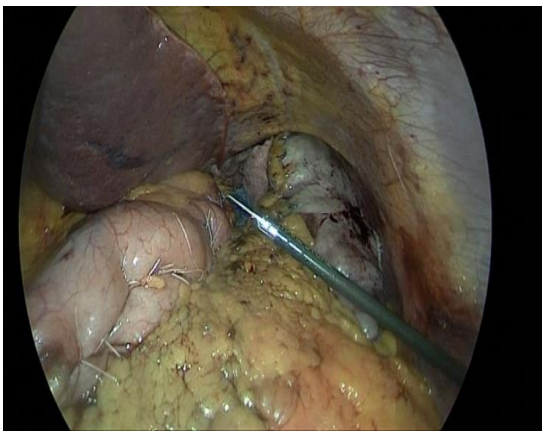

Figure [3]: The first row of greater curvature plication

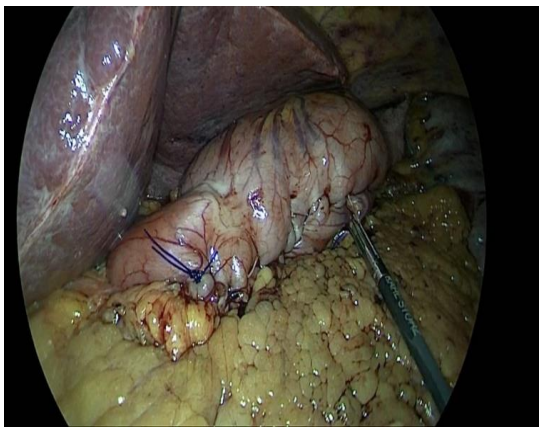

Figure [4]: The final Appearance after Fundectomy with greater curvature plication

Postoperative care: The patient stays in the recovery room for 2-3 hours. One-day admission in the intensive care unit, if needed. Oral intake with sips of clear water was permitted in the day after operation.

The postoperative diet: The postoperative diet was outlined as follows: a tailored liquid diet for the first two weeks, followed by a gradual reintroduction of solid foods in a stepwise manner, with dietary restrictions lifted between 4 to 6 weeks, based on the patient's tolerance. Meticulous management of the patient's diet is essential for effective weight loss. Initially, as with other restrictive approaches, the diet starts with soft liquids like water, milk, and fruit juice [50 cc each for the first two weeks]. In the second stage, patients are advised to avoid sugars in liquids but can consume soft cooked liquids for the following two weeks. The third stage includes thicker liquids such as yogurt and fruits for an additional two weeks. The final stage allows all types of food, with the only limitation being the volume of each meal, capped at four spoonsful. Positive outcomes were linked to reduced carbohydrates and fats while increasing vitamin and protein intake. After one month after operation, the exercise [walking for 60 minutes/ day] was advocated. Usually patients discharge from hospital at the second or third day after surgery.

Postoperative prescription of Proton pump inhibitor for one-month, low molecular weight heparin for one week until full mobilization, good hydration, and avoid sweet eating.

Postoperative follow up: Follow up after one week, one month, three months, six months, one year and two years for assessment of bleeding, gastric leak, stricture, percentage of excess body weight loss [EBW %], effect on comorbid diseases, pulmonary complications, gastroesophageal reflux disease [GERD] and hiatus hernia, vomiting, nutritional impact, wound infection and reoperation.

Outcome: Success was defined as the ability to achieve 40% or more of EBWL percentage; those who fail to achieve this percentage is nominated as failure

Statistical analysis of data: Collected data were presented in appropriate statistics measures [mean, standard deviation, minimum and maximum for quantitative data; frequency a percentage for categorical data]. Repeated analysis of variance was used to examine the effect of intervention at the end of follow up. All were completed by statistical package for social science [SPSS] version 18 [SPSS Inc., USA]. P value < 0.05 was considered significant.

RESULTS

The patient characteristics were presented in table [1]. Males represented 28%, the most common age group was 35 to 45 years [76.0%], the mean age was 37.1±1.2 years. The married patients represented 56%; the onset of obesity in childhood [60.0%] and adulthood [40.0%]. The body mass index ranged between 40 to 54 kg/m^2. Obesity related complications were in the form of diabetes mellitus [DM], hypertension [HTN], arthritis and sleep apnea syndrome [SAS] in 32.0%, 16.0%, 28.0% and 8.0% respectively [Table 1].

The operative time ranged between 90 and 190 minutes; the mean operative time 118.3 ± 29.7 minutes; none of studied patients converted from laparoscopic to open surgery; the hospital stay duration ranged between 1 to 4 days [mean ± SD 1.6±0.78 days]; 8% and 4% were submitted to laparoscopic cholecystectomy and periumbilical hernia repair respectively. The complications were in the form of seroma, port site infection, nausea, persistent vomiting, postoperative bleeding, and cholelithiasis among 8%, 4%, 8%, 16%, and 4% respectively. No one had intraoperative bleeding, stricture, ulcer, or leak [Table 2].

In the current work, there was progressive increase of estimated body weight loss from the first postoperative week till the end of the second year of follow up. In addition, there was improvement of associated comorbidities [hyper-tension was improved or completely disappeared in 3 out of 4 patients, while diabetes improved or disappeared in 6 out of 8 patients, arthritis improved in 3 out of 7 patients and sleep apnea syndrome completely resolved in 2 patients who had SAS [Table 3].

There were two patients [8%] who cannot loss more than [40%] of EBWL% and categorized as failed operation which may be referred to dilatation of the stomach at the part of greater curvature plication, the patient arranged for re-operation for completion of sleeve with bypass. No mortality was occurred at follow up period.

Table [1]: Demographic data and obesity related complications

Variables		Statistics [n=25]
Gender [male/female], n [%]		7/18 [28/72%]
Age [years]	Mean ± SD [range] 20-35 years 35-45	37.1 ± 1.2; 20-45 6 [24.0%] 19 [76.0%]
Marital status [single/married], n [%]		11/14 [44/56%]
Onset of obesity [childhood/adulthood], n [%]		15/10 [60/40%]
Body mass index [mean ± SD]; range		45.7 ± 4.5 [40-54]
Obesity related complications	Diabetes mellitus	8 [32.0%]
	Hypertension	4 [16.0%]
	Arthritis	7 [28.0%]
	Sleep apnea syndrome	2 [8.0%]

Table [2]: Distribution of the studied group according to operative details and complications

Variables		Statistics [n=25]
Operative time [minutes] [mean ± SD; range]		118.3 ± 29.7; 90-190
Conversion to open		0 [0.0%]
Hospital stay [day] [mean ± SD; range]		1.6±0.78; 1-4
Associated procedures	Laparoscopic cholecystectomy	2 [8.0%]
	Para-umbilical hernia repair	1 [4.0%]
Complications	Seroma	2 [8.0%]
	Port site infection	1 [4.0%]
	Nausea	2 [8.0%]
	Persistent vomiting	4 [16.0%]
	Intraoperative bleeding	0 [0.0%]
	Postoperative bleeding	1 [4.0%]
	Stricture	0 [0.0%]
	Ulcer	0 [0.0%]
	Leak	0 [0.0%]
	Cholelithiasis	2 [8.0%]

Table [3]: Estimated body weight loss and improvement of comorbidities at follow up period

	EBWL				HTM	DM	Arthritis	SAS
	Mean	SD	Min.	M.				
First week	0.9	0.6	0.4	1.9	4/25 [16.0%]	8/25 [32.0%]	7/25 [28.0%]	2/25 [8.0%]
First month	7.0	2.6	2.5	10.8	4/25 [16.0%]	7/8 [87.5%]	7/25 [28.0%]	2/25 [8.0%]
Third month	19	4.5	16.5	25.1	4/25 [16.0%]	7/8 [87.5%]	4/7 [57.2%]	2/25 [8.0%]
Six months	38	8.2	33.6	42.7	3/4 [75.0%]	5/8 [62.5%]	4/7 [57.2%]	2/25 [8.0%]
One year	56	11.2	51.7	60.2	2/4 [50.0%]	4/8 [50.0%]	2/7 [28.6%]	0/2 [0.0%]
Two years	62	9.3	53.3	72.7	1/4 [25.0%]	2/8 [25.0%]	4/7 [57.2%]	0/2 [0.0%]
Repeated ANOVA	P < 0.001*							

DISCUSSION

We conducted this study is to evaluate the feasibility of laparoscopic gastric fundectomy with grater curvature plication of the remaining part of the stomach for management of morbid obesity, its safety and effect on weight loss. Results revealed that, the procedure is relatively safe with low complications and excellent results regarding excess weight loss. Females represented the majority of studied subjects [72.0%]. This is in line with **Boza *et al.*** [14]. This could be explained by the fact that, females are more prone to psychosocial problems, and concerned about the cosmetic effects of obesity. Various factors contribute to gender differences in food consumption, with women frequently reporting higher intake of sugary foods compared to men. Additionally, in certain countries, cultural beliefs associate larger body sizes in women with fertility and health. Women are often heavily protected, and cultural or religious constraints can limit their public participation in physical activities. In Egypt, there is also a notable cultural acceptance of increased weight gain among women compared to men [15-16].

In the current work, complication rate appears to be generally low, minor complications as nausea

[8%] and persistent vomiting [16%] are the most common complications. These results are in line with **Chouillard *et al.*** [13] who reported that, nausea and vomiting presented in 20% after laparoscopic greater curvature plication [LGCP] and 7.5% after laparoscopic sleeve gastrectomy [LSG]. The principle difference between LSG and LGCP is the existence of the end luminal fold [17]. In addition, **Skrekas *et al.*** [18] reported that, nausea and/or vomiting are significantly improved after the modified LGCP technique by the construction of a double or triple plication of the apposed gastric wall than the first row of stitches.

In the present work, there was one case with persistent vomiting, which, on reoperation was found to be caused by a single adhesion causing a kink in the plicated stomach, one case of early post-operative leak, which attributed to high endogastric pressure because of persistent vomiting. Comparable results were reported in previous literature [12].

In this study, there was leak among 4% of studied populations. **Rosenthal *et al.*** [19] reported that, gastrointestinal [GI] leak after bariatric surgery is not an uncommon complication and one that can be expected to occur at some point in every bariatric surgeon's experience. The reported incidence in literature varies according to the procedure, LGBP [0.7–5.3%] and for LSG [1.1–7.1%] [20].

The esophagogastric [EG] junction is commonly identified as the usual site for leaks following laparoscopic sleeve gastrectomy [LSG]. Close attention should be paid to this area during stapling. It's crucial to use staples of appropriate height and to avoid stapling the esophagus [21]. **Giuliani *et al.*** [22] noted that acute leaks are the most dangerous complication, potentially leading to fatal outcomes, and there are no standardized protocols for managing them. Leaks typically occur at either the proximal or distal ends of the staple line, with proximal gastric leaks accounting for over 90% of leaks following LSG. **Gagner *et al.*** [23] identified mechanical factors, such as high intragastric pressure from an L-shaped sleeve, physiological pyloric obstruction, hematoma or edema, and the use of a bougie that is too small or reinforcing sutures that create excessive narrowing, as causes of leaks within the first two postoperative days. They also indicated that tissue-related factors can lead to leaks up to six days post-surgery.

In the current study the incidence of post-operative bleeding was 4%. It was reported that the incidence of bleeding after obesity surgery ranges from 0.6 to 3% [24]. The small number of cases could be responsible for exaggerated rate of complications. Stapling a thick, vascular gastric wall may result in significant bleeding both within the lumen and in the surrounding peritoneal cavity.

Regarding EWL, results are of the present study are comparable to previous studies. For examples, one study reported that, the mean EWL of 21.4% at 1 month, 54% at 6 months, 61% at 12 months, 60% at 24 months, and 57% at 36 months [12]. In addition, **t**he mean %EWL was 51.7% at 6 months, 67.1% at 12 months, and 65.2% at 24 months in the publication of **Skrekas *et al.*** [18].

In their series of 42 cases, **Ramos *et al.*** [25] reported a mean %EWL of 20% for the first month, 32% at 3 months, 48% at 6 months, 60% at 12 months, and 62% at 18 months. The result of EWL in this study was much lower than the published studies and we believe that this may be because of the lack of a standard technique for the operation or poor compliance of some of patients to strict adherence of follow-up dietary instructions.

Failure after bariatric surgery in the current study is in line with **Verdi *et al.*** [26] who reported that, insufficient weight loss and were in 60% of cases after LGCP and in 8.8 % of cases after LSG. In addition, **Skrekas *et al.*** [18] reported a failed operation [%EWL<30%] in 6% of patients, and an insufficient weight loss [% EWL <50 %] in greater than 21 % of patients underwent LGCP.

It has been reported that the most frequent causes of death in bariatric surgery are pulmonary embolism, cardiac or respiratory failure and gastric fistula [27]. In the current study, no mortality was occurred at follow up period.

As regard comorbidities, improvement is defined as a decrease in medication use, while resolution refers to the complete elimination of medications and biochemical normalization [28]. In the current study, which focused on weight loss and outcomes for type 2 diabetes, laparoscopic gastric bypass was performed on 55 morbidly obese diabetic patients with a one-year follow-up. After 12 months, the average glycated hemoglobin level was 7.5% [ranging from 5.5% to 8%]. Prior to surgery, all patients were taking oral anti-diabetic medications and none had been living with the disease for more than five years. None of the patients discontinued their diabetes medications after the surgery [29]. However, a published multi-

center international study on the impact of laparoscopic gastric bypass on type 2 diabetes mellitus suggests that the metabolic effects of this procedure fall between those of adjustable gastric banding and sleeve gastrectomy. Thus, laparoscopic gastric bypass appears to be more effective for type 2 diabetes than gastric banding but slightly less effective than sleeve gastrectomy [30]. Hypertension resolution was defined as normal blood pressure [diastolic <80 mmHg and systolic <140 mmHg] in the absence of antihypertensive drugs. In line with this study, reported that 66.7 % hypertension remission after 6 months in LGCP and the improvement was 33.4 % of hypertension 6 months after LGCP [31]. In the terms of sleep apnea syndrome in line with the present study found that the resolution of sleep apnea at 1 year was comparable in both LSG and LRYGB group and the resolution percentage in both groups was 100% [32]. A systematic review revealed that 75% of patients with sleep apnea experienced at least some improvement in their condition following bariatric surgery. Among the various interventions, laparoscopic biliopancreatic diversion [BPD] proved to be the most effective for improving or resolving obstructive sleep apnea, while laparoscopic adjustable gastric banding was the least effective. Improvements were observed regardless of the specific type of sleep apnea [33].

The small number of patients included in the current study is one limiting step which prevents generalization of results and thus, future large-scale studies are warranted. In addition, we compared results with different bariatric procedures due to absence of similar technique in previous studies. However, results of the current work are promising with high efficacy and safety profiles.

In conclusion, laparoscopic gastric fundectomy with grater curvature plication of the remaining part of the stomach in morbid obesity is an effective and relatively safe procedure, with promising results.

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Original Article

Laparoscopic Gastric Fundectomy with Greater Curvature Plication: A Feasibility Study for Obese Patients

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ABSTRACT

Background: Obesity is a worldwide epidemic. Bariatric surgery is a curative management intervention. However, it is not devoid of comorbidities. Different modalities were continuously developed to increase effectiveness and safety.

The aim of the work: To evaluate the feasibility of laparoscopic gastric fundectomy with greater curvature plication of the remaining part of the stomach for the management of morbid obesity.

Patients and Methods: Twenty-five patients with morbid obesity were included. All patients were preoperatively assessed through full history taking and clinical examination. In addition, all underwent routine laboratory and radiological investigations to establish their fitness for surgery. After surgery, patients were followed up after one week, 1, 3, 6 months, one and two years for assessment of effective weight loss and comorbidities [e.g., bleeding, gastric leak, stricture, etc.]. Success was defined as the ability to achieve 40% or more of estimated body weight loss [EBWL].

Results: Males represented 28%. The most common age group was 35 to 45 years [76.0%]. The married patients were 56%; and childhood onset of obesity was [60.0%]. Obesity-related complications were in the form of diabetes, hypertension, arthritis, and sleep apnea syndrome in 32.0%, 16.0%, 28.0%, and 8.0%, respectively. The complications included seroma, port site infection, nausea, persistent vomiting, postoperative bleeding, and cholelithiasis among 8%, 4%, 8%, 16%, and 4%, respectively. Finally, there was a progressive increase of estimated body weight loss from the first postoperative week until the end of the second year of follow-up. In addition, there was an improvement of associated comorbidities at the end of the follow-up period. The failure rate was [8%]. No mortality occurred during the follow-up period.

Conclusion: Laparoscopic gastric fundectomy with greater curvature plication of the remaining part of the stomach in morbid obesity is an effective and relatively safe procedure, with promising results.

Keywords: Fundectomy; Laparascopic; Greater curvature plication; Obesity; Morbid.

INTRODUCTION

Obesity become a worldwide epidemic. This is attributable to change in dietary habits [e.g., fast unhealthy foods] and sedentary lifestyles. It affects more than 20% of adults [10.8% of men [266 million] and 14.9% of women [375 million] worldwide in 2014] and 20.1% of children aged 6 years [1-3].

Obesity is associated with excess body fat accumulation, which could be associated with an adverse health effect, with potential reduction of life expectancy and/or increased health comorbidities. Body mass index [BMI], is a measurement used to recognize and classify overweight and obesity. Accordingly, overweight [pre-obese] is defined as BMI between 25 and 30 kg/m^2, and obese when it is greater than 30 kg/m^2 [4].

Bariatric Surgery was introduced in the last 60 years. However, it did not gain wide acceptance except recently. Its benefits had not been restricted to weight loss, but it usually associated with benefits for every single organ or function. Notably, patients with diabetes mellitus, hypertension, hyperlipidemia, chronic obstructive pulmonary disease [COPD], obstructive sleep apnea, arthritis and gastroesophageal reflux disease are improved with bariatric surgery. In addition, different studies appreciated the effect of bariatric surgery for renal, cardiac and mental functions [5-8].

Bariatric surgeries could be malabsorptive as biliopancreatic diversion [BPD], or restrictive innervations, such as vertical banded gastroplasty [VBG], Laparoscopic sleeve gastrectomy [LSG], Laparoscopic greater curvature plication [LGCP]. Each procedure has its advantages and disadvantages. Thus, the selection of the bariatric procedure should be individualized and selected with great caution [9-11].

Greater curvature plication [GCP] is viewed as a restrictive procedure that helps prevent complications linked to the permanent placement of an adjustable gastric band, while also reducing the risk of leaks associated with sleeve gastrectomy. It was initially introduced in 2007. This technique involves cutting the short gastric vessels but does not require stapling or removal of tissue, which may offer some benefits over sleeve gastrectomy [12, 13].

To avoid possible complications associated with bariatric surgery, we introduced gastric fundectomy with Greater Curvature Plication. Initial experience with open procedure is under publications, and here we presented our initial experience with laparoscopic procedure.

The aim of this work is to assess the feasibility of laparoscopic gastric fundectomy with grater curvature plication of the remaining part of the stomach for management of morbid obesity, its safety and effect on the weight loss.

PATIENTS AND METHODS

This study included 25 patients with morbid obesity, who were scheduled for laparoscopic gastric fundectomy with greater curvature plication of the remaining part of the stomach. It had been carried out at Damietta University Hospital [Al-Azhar University] from October 2017 to October 2019. We included patients aged 20- 45 years old, who had BMI greater than or equal to 35 kg/m^2, non-sweet eaters, with no endocrinal disturbances, who failed other measures to lose weight, who had no gastroesophageal reflux disease [GERD] or hiatus hernia, and with no previous upper gastrointestinal [GIT] surgery. On the other side, we excluded patients younger than 20 years or older than 45 years of age, who unfit for anesthesia and surgery, sweet eaters, with previous upper GIT surgeries, and who had unmanageable psychological disturbances.

Ethical considerations: Consent was obtained from all patients after explanation of the procedure and expected complications. Approval by Ethical and Medical Committee faculty of medicine, Al-Azhar University [Damietta] was obtained.

All eligible subjects were submitted to:

1. Preoperative assessment [full medical and surgical history taking, weight and height to calculate body mass index [BMI], psychological assessment, assessment of dietary habits of patients and previous trials of weight reduction, and evaluation of associated co-morbidity and treatment medications used [diabetes, hypertension, arthritis and obstructive sleep apnea syndrome]].

2. Laboratory investigations included complete blood picture [CBC], liver function tests [SGPT-SGOT-S. bilirubin- S. albumin], coagulation profile [bleeding time, partial thromboplastin time and international normalization ratio], arterial blood gases [ABG], fasting and post prandial blood glucose, renal function tests [serum creatinine and blood urea], profile functions of thyroid gland, serum cortisol. In addition, imaging studies included

chest X-ray, abdominal ultrasonography and duplex ultrasound to both lower limbs, and upper GIT Endoscopy.

Operative details: Under general anesthesia, patients were positioned in a reverse Trendelenburg position, angled 30° upwards. The camera operator stood on the patient's right side, while the assistant was on the left. The surgeon positioned himself between the patient's legs. A prophylactic dose of one gram of a third-generation cephalosporin was administered. After establishing pneumoperitoneum, five ports were inserted: one 10 mm optical port above the umbilicus, one 12 mm port in the right midclavicular line above the optical port level, one 5 mm port in the left midclavicular line above the optical port level, one 5 mm port below the xiphoid for liver retraction, and one 5 mm port in the left anterior axillary line. The blood supply to the greater curvature of the stomach was divided starting 4-6 cm from the pylorus and continuing upward to the angle of His using a vessel sealing device. Occasionally, posterior gastric adhesions were also cut to ensure optimal mobility [Figure 1].

Fundectomy: Planning of the fundic part which was excised, then fundectomy was performed using a linear stapler with about three sequential blue cartridges. Good hemostasis was obtained with medium sized clips [figure 2].

Greater curvature plication: After removal of the fundus, 32-fr calibrating bougie inserted against lesser curvature to the pylorus then the gastric plication was performed by folding the greater curvature, utilizing a first row of interrupted non-absorbable 0 sutures in a seromuscular fashion to stay clear of gastric acid [Figure 3]. The spacing between the sutures ranged from 1.0 to 1.5 cm. A second row of running non-absorbable 0 sutures was added for reinforcement, ensuring the plication was secure and preventing any herniation between the sutures [Figure 4]. A leak test was conducted by applying pressure on the pylorus and injecting 100 ml of methylene blue through the bougie. One drain was placed in the surgical area, and the port sites were closed with sutures.

Figure [1]: Devascularization of the greater curvature

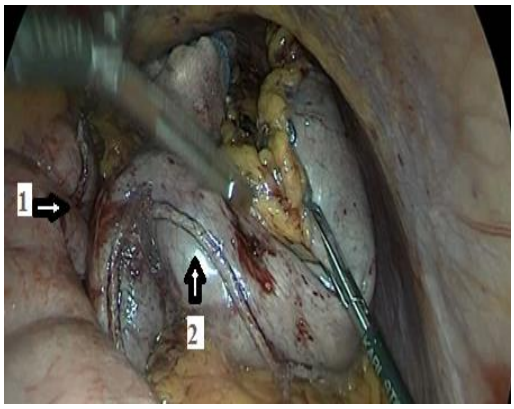

Figure [2]: The appearance of stomach after fundectomy; [1] Stapler line of fundectomy. [2] Removed fundus.

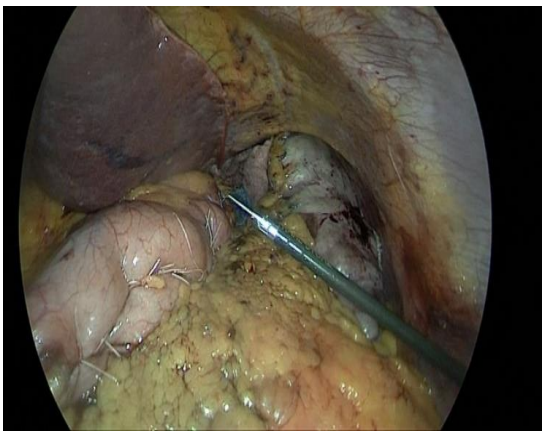

Figure [3]: The first row of greater curvature plication

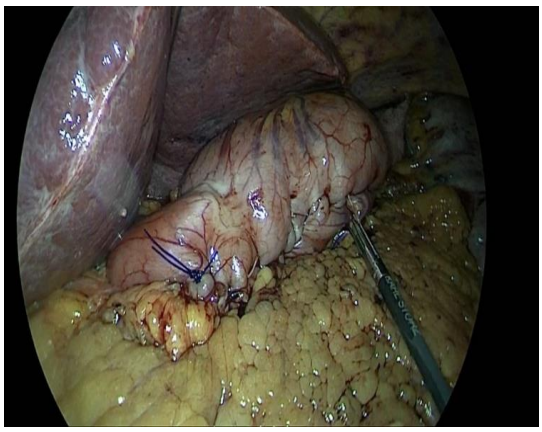

Figure [4]: The final Appearance after Fundectomy with greater curvature plication

Postoperative care: The patient stays in the recovery room for 2-3 hours. One-day admission in the intensive care unit, if needed. Oral intake with sips of clear water was permitted in the day after operation.

The postoperative diet: The postoperative diet was outlined as follows: a tailored liquid diet for the first two weeks, followed by a gradual reintroduction of solid foods in a stepwise manner, with dietary restrictions lifted between 4 to 6 weeks, based on the patient's tolerance. Meticulous management of the patient's diet is essential for effective weight loss. Initially, as with other restrictive approaches, the diet starts with soft liquids like water, milk, and fruit juice [50 cc each for the first two weeks]. In the second stage, patients are advised to avoid sugars in liquids but can consume soft cooked liquids for the following two weeks. The third stage includes thicker liquids such as yogurt and fruits for an additional two weeks. The final stage allows all types of food, with the only limitation being the volume of each meal, capped at four spoonsful. Positive outcomes were linked to reduced carbohydrates and fats while increasing vitamin and protein intake. After one month after operation, the exercise [walking for 60 minutes/ day] was advocated. Usually patients discharge from hospital at the second or third day after surgery.

Postoperative prescription of Proton pump inhibitor for one-month, low molecular weight heparin for one week until full mobilization, good hydration, and avoid sweet eating.

Postoperative follow up: Follow up after one week, one month, three months, six months, one year and two years for assessment of bleeding, gastric leak, stricture, percentage of excess body weight loss [EBW %], effect on comorbid diseases, pulmonary complications, gastroesophageal reflux disease [GERD] and hiatus hernia, vomiting, nutritional impact, wound infection and reoperation.

Outcome: Success was defined as the ability to achieve 40% or more of EBWL percentage; those who fail to achieve this percentage is nominated as failure

Statistical analysis of data: Collected data were presented in appropriate statistics measures [mean, standard deviation, minimum and maximum for quantitative data; frequency a percentage for categorical data]. Repeated analysis of variance was used to examine the effect of intervention at the end of follow up. All were completed by statistical package for social science [SPSS] version 18 [SPSS Inc., USA]. P value < 0.05 was considered significant.

RESULTS

The patient characteristics were presented in table [1]. Males represented 28%, the most common age group was 35 to 45 years [76.0%], the mean age was 37.1±1.2 years. The married patients represented 56%; the onset of obesity in childhood [60.0%] and adulthood [40.0%]. The body mass index ranged between 40 to 54 kg/m^2. Obesity related complications were in the form of diabetes mellitus [DM], hypertension [HTN], arthritis and sleep apnea syndrome [SAS] in 32.0%, 16.0%, 28.0% and 8.0% respectively [Table 1].

The operative time ranged between 90 and 190 minutes; the mean operative time 118.3 ± 29.7 minutes; none of studied patients converted from laparoscopic to open surgery; the hospital stay duration ranged between 1 to 4 days [mean ± SD 1.6±0.78 days]; 8% and 4% were submitted to laparoscopic cholecystectomy and periumbilical hernia repair respectively. The complications were in the form of seroma, port site infection, nausea, persistent vomiting, postoperative bleeding, and cholelithiasis among 8%, 4%, 8%, 16%, and 4% respectively. No one had intraoperative bleeding, stricture, ulcer, or leak [Table 2].

In the current work, there was progressive increase of estimated body weight loss from the first postoperative week till the end of the second year of follow up. In addition, there was improvement of associated comorbidities [hyper-tension was improved or completely disappeared in 3 out of 4 patients, while diabetes improved or disappeared in 6 out of 8 patients, arthritis improved in 3 out of 7 patients and sleep apnea syndrome completely resolved in 2 patients who had SAS [Table 3].

There were two patients [8%] who cannot loss more than [40%] of EBWL% and categorized as failed operation which may be referred to dilatation of the stomach at the part of greater curvature plication, the patient arranged for re-operation for completion of sleeve with bypass. No mortality was occurred at follow up period.

Table [1]: Demographic data and obesity related complications

Variables		Statistics [n=25]
Gender [male/female], n [%]		7/18 [28/72%]
Age [years]	Mean ± SD [range] 20-35 years 35-45	37.1 ± 1.2; 20-45 6 [24.0%] 19 [76.0%]
Marital status [single/married], n [%]		11/14 [44/56%]
Onset of obesity [childhood/adulthood], n [%]		15/10 [60/40%]
Body mass index [mean ± SD]; range		45.7 ± 4.5 [40-54]
Obesity related complications	Diabetes mellitus	8 [32.0%]
	Hypertension	4 [16.0%]
	Arthritis	7 [28.0%]
	Sleep apnea syndrome	2 [8.0%]

Table [2]: Distribution of the studied group according to operative details and complications

Variables		Statistics [n=25]
Operative time [minutes] [mean ± SD; range]		118.3 ± 29.7; 90-190
Conversion to open		0 [0.0%]
Hospital stay [day] [mean ± SD; range]		1.6±0.78; 1-4
Associated procedures	Laparoscopic cholecystectomy	2 [8.0%]
	Para-umbilical hernia repair	1 [4.0%]
Complications	Seroma	2 [8.0%]
	Port site infection	1 [4.0%]
	Nausea	2 [8.0%]
	Persistent vomiting	4 [16.0%]
	Intraoperative bleeding	0 [0.0%]
	Postoperative bleeding	1 [4.0%]
	Stricture	0 [0.0%]
	Ulcer	0 [0.0%]
	Leak	0 [0.0%]
	Cholelithiasis	2 [8.0%]

Table [3]: Estimated body weight loss and improvement of comorbidities at follow up period

	EBWL				HTM	DM	Arthritis	SAS
	Mean	SD	Min.	M.				
First week	0.9	0.6	0.4	1.9	4/25 [16.0%]	8/25 [32.0%]	7/25 [28.0%]	2/25 [8.0%]
First month	7.0	2.6	2.5	10.8	4/25 [16.0%]	7/8 [87.5%]	7/25 [28.0%]	2/25 [8.0%]
Third month	19	4.5	16.5	25.1	4/25 [16.0%]	7/8 [87.5%]	4/7 [57.2%]	2/25 [8.0%]
Six months	38	8.2	33.6	42.7	3/4 [75.0%]	5/8 [62.5%]	4/7 [57.2%]	2/25 [8.0%]
One year	56	11.2	51.7	60.2	2/4 [50.0%]	4/8 [50.0%]	2/7 [28.6%]	0/2 [0.0%]
Two years	62	9.3	53.3	72.7	1/4 [25.0%]	2/8 [25.0%]	4/7 [57.2%]	0/2 [0.0%]
Repeated ANOVA	P < 0.001*							

DISCUSSION

We conducted this study is to evaluate the feasibility of laparoscopic gastric fundectomy with grater curvature plication of the remaining part of the stomach for management of morbid obesity, its safety and effect on weight loss. Results revealed that, the procedure is relatively safe with low complications and excellent results regarding excess weight loss. Females represented the majority of studied subjects [72.0%]. This is in line with **Boza *et al.*** [14]. This could be explained by the fact that, females are more prone to psychosocial problems, and concerned about the cosmetic effects of obesity. Various factors contribute to gender differences in food consumption, with women frequently reporting higher intake of sugary foods compared to men. Additionally, in certain countries, cultural beliefs associate larger body sizes in women with fertility and health. Women are often heavily protected, and cultural or religious constraints can limit their public participation in physical activities. In Egypt, there is also a notable cultural acceptance of increased weight gain among women compared to men [15-16].

In the current work, complication rate appears to be generally low, minor complications as nausea

[8%] and persistent vomiting [16%] are the most common complications. These results are in line with **Chouillard *et al.*** [13] who reported that, nausea and vomiting presented in 20% after laparoscopic greater curvature plication [LGCP] and 7.5% after laparoscopic sleeve gastrectomy [LSG]. The principle difference between LSG and LGCP is the existence of the end luminal fold [17]. In addition, **Skrekas *et al.*** [18] reported that, nausea and/or vomiting are significantly improved after the modified LGCP technique by the construction of a double or triple plication of the apposed gastric wall than the first row of stitches.

In the present work, there was one case with persistent vomiting, which, on reoperation was found to be caused by a single adhesion causing a kink in the plicated stomach, one case of early post-operative leak, which attributed to high endogastric pressure because of persistent vomiting. Comparable results were reported in previous literature [12].

In this study, there was leak among 4% of studied populations. **Rosenthal *et al.*** [19] reported that, gastrointestinal [GI] leak after bariatric surgery is not an uncommon complication and one that can be expected to occur at some point in every bariatric surgeon's experience. The reported incidence in literature varies according to the procedure, LGBP [0.7–5.3%] and for LSG [1.1–7.1%] [20].

The esophagogastric [EG] junction is commonly identified as the usual site for leaks following laparoscopic sleeve gastrectomy [LSG]. Close attention should be paid to this area during stapling. It's crucial to use staples of appropriate height and to avoid stapling the esophagus [21]. **Giuliani *et al.*** [22] noted that acute leaks are the most dangerous complication, potentially leading to fatal outcomes, and there are no standardized protocols for managing them. Leaks typically occur at either the proximal or distal ends of the staple line, with proximal gastric leaks accounting for over 90% of leaks following LSG. **Gagner *et al.*** [23] identified mechanical factors, such as high intragastric pressure from an L-shaped sleeve, physiological pyloric obstruction, hematoma or edema, and the use of a bougie that is too small or reinforcing sutures that create excessive narrowing, as causes of leaks within the first two postoperative days. They also indicated that tissue-related factors can lead to leaks up to six days post-surgery.

In the current study the incidence of post-operative bleeding was 4%. It was reported that the incidence of bleeding after obesity surgery ranges from 0.6 to 3% [24]. The small number of cases could be responsible for exaggerated rate of complications. Stapling a thick, vascular gastric wall may result in significant bleeding both within the lumen and in the surrounding peritoneal cavity.

Regarding EWL, results are of the present study are comparable to previous studies. For examples, one study reported that, the mean EWL of 21.4% at 1 month, 54% at 6 months, 61% at 12 months, 60% at 24 months, and 57% at 36 months [12]. In addition, **t**he mean %EWL was 51.7% at 6 months, 67.1% at 12 months, and 65.2% at 24 months in the publication of **Skrekas *et al.*** [18].

In their series of 42 cases, **Ramos *et al.*** [25] reported a mean %EWL of 20% for the first month, 32% at 3 months, 48% at 6 months, 60% at 12 months, and 62% at 18 months. The result of EWL in this study was much lower than the published studies and we believe that this may be because of the lack of a standard technique for the operation or poor compliance of some of patients to strict adherence of follow-up dietary instructions.

Failure after bariatric surgery in the current study is in line with **Verdi *et al.*** [26] who reported that, insufficient weight loss and were in 60% of cases after LGCP and in 8.8 % of cases after LSG. In addition, **Skrekas *et al.*** [18] reported a failed operation [%EWL<30%] in 6% of patients, and an insufficient weight loss [% EWL <50 %] in greater than 21 % of patients underwent LGCP.

It has been reported that the most frequent causes of death in bariatric surgery are pulmonary embolism, cardiac or respiratory failure and gastric fistula [27]. In the current study, no mortality was occurred at follow up period.

As regard comorbidities, improvement is defined as a decrease in medication use, while resolution refers to the complete elimination of medications and biochemical normalization [28]. In the current study, which focused on weight loss and outcomes for type 2 diabetes, laparoscopic gastric bypass was performed on 55 morbidly obese diabetic patients with a one-year follow-up. After 12 months, the average glycated hemoglobin level was 7.5% [ranging from 5.5% to 8%]. Prior to surgery, all patients were taking oral anti-diabetic medications and none had been living with the disease for more than five years. None of the patients discontinued their diabetes medications after the surgery [29]. However, a published multi-

center international study on the impact of laparoscopic gastric bypass on type 2 diabetes mellitus suggests that the metabolic effects of this procedure fall between those of adjustable gastric banding and sleeve gastrectomy. Thus, laparoscopic gastric bypass appears to be more effective for type 2 diabetes than gastric banding but slightly less effective than sleeve gastrectomy [30]. Hypertension resolution was defined as normal blood pressure [diastolic <80 mmHg and systolic <140 mmHg] in the absence of antihypertensive drugs. In line with this study, reported that 66.7 % hypertension remission after 6 months in LGCP and the improvement was 33.4 % of hypertension 6 months after LGCP [31]. In the terms of sleep apnea syndrome in line with the present study found that the resolution of sleep apnea at 1 year was comparable in both LSG and LRYGB group and the resolution percentage in both groups was 100% [32]. A systematic review revealed that 75% of patients with sleep apnea experienced at least some improvement in their condition following bariatric surgery. Among the various interventions, laparoscopic biliopancreatic diversion [BPD] proved to be the most effective for improving or resolving obstructive sleep apnea, while laparoscopic adjustable gastric banding was the least effective. Improvements were observed regardless of the specific type of sleep apnea [33].

The small number of patients included in the current study is one limiting step which prevents generalization of results and thus, future large-scale studies are warranted. In addition, we compared results with different bariatric procedures due to absence of similar technique in previous studies. However, results of the current work are promising with high efficacy and safety profiles.

In conclusion, laparoscopic gastric fundectomy with grater curvature plication of the remaining part of the stomach in morbid obesity is an effective and relatively safe procedure, with promising results.

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Original Article

Laparoscopic Gastric Fundectomy with Greater Curvature Plication: A Feasibility Study for Obese Patients

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ABSTRACT

Background: Obesity is a worldwide epidemic. Bariatric surgery is a curative management intervention. However, it is not devoid of comorbidities. Different modalities were continuously developed to increase effectiveness and safety.

The aim of the work: To evaluate the feasibility of laparoscopic gastric fundectomy with greater curvature plication of the remaining part of the stomach for the management of morbid obesity.

Patients and Methods: Twenty-five patients with morbid obesity were included. All patients were preoperatively assessed through full history taking and clinical examination. In addition, all underwent routine laboratory and radiological investigations to establish their fitness for surgery. After surgery, patients were followed up after one week, 1, 3, 6 months, one and two years for assessment of effective weight loss and comorbidities [e.g., bleeding, gastric leak, stricture, etc.]. Success was defined as the ability to achieve 40% or more of estimated body weight loss [EBWL].

Results: Males represented 28%. The most common age group was 35 to 45 years [76.0%]. The married patients were 56%; and childhood onset of obesity was [60.0%]. Obesity-related complications were in the form of diabetes, hypertension, arthritis, and sleep apnea syndrome in 32.0%, 16.0%, 28.0%, and 8.0%, respectively. The complications included seroma, port site infection, nausea, persistent vomiting, postoperative bleeding, and cholelithiasis among 8%, 4%, 8%, 16%, and 4%, respectively. Finally, there was a progressive increase of estimated body weight loss from the first postoperative week until the end of the second year of follow-up. In addition, there was an improvement of associated comorbidities at the end of the follow-up period. The failure rate was [8%]. No mortality occurred during the follow-up period.

Conclusion: Laparoscopic gastric fundectomy with greater curvature plication of the remaining part of the stomach in morbid obesity is an effective and relatively safe procedure, with promising results.

Keywords: Fundectomy; Laparascopic; Greater curvature plication; Obesity; Morbid.

INTRODUCTION

Obesity become a worldwide epidemic. This is attributable to change in dietary habits [e.g., fast unhealthy foods] and sedentary lifestyles. It affects more than 20% of adults [10.8% of men [266 million] and 14.9% of women [375 million] worldwide in 2014] and 20.1% of children aged 6 years [1-3].

Obesity is associated with excess body fat accumulation, which could be associated with an adverse health effect, with potential reduction of life expectancy and/or increased health comorbidities. Body mass index [BMI], is a measurement used to recognize and classify overweight and obesity. Accordingly, overweight [pre-obese] is defined as BMI between 25 and 30 kg/m^2, and obese when it is greater than 30 kg/m^2 [4].

Bariatric Surgery was introduced in the last 60 years. However, it did not gain wide acceptance except recently. Its benefits had not been restricted to weight loss, but it usually associated with benefits for every single organ or function. Notably, patients with diabetes mellitus, hypertension, hyperlipidemia, chronic obstructive pulmonary disease [COPD], obstructive sleep apnea, arthritis and gastroesophageal reflux disease are improved with bariatric surgery. In addition, different studies appreciated the effect of bariatric surgery for renal, cardiac and mental functions [5-8].

Bariatric surgeries could be malabsorptive as biliopancreatic diversion [BPD], or restrictive innervations, such as vertical banded gastroplasty [VBG], Laparoscopic sleeve gastrectomy [LSG], Laparoscopic greater curvature plication [LGCP]. Each procedure has its advantages and disadvantages. Thus, the selection of the bariatric procedure should be individualized and selected with great caution [9-11].

Greater curvature plication [GCP] is viewed as a restrictive procedure that helps prevent complications linked to the permanent placement of an adjustable gastric band, while also reducing the risk of leaks associated with sleeve gastrectomy. It was initially introduced in 2007. This technique involves cutting the short gastric vessels but does not require stapling or removal of tissue, which may offer some benefits over sleeve gastrectomy [12, 13].

To avoid possible complications associated with bariatric surgery, we introduced gastric fundectomy with Greater Curvature Plication. Initial experience with open procedure is under publications, and here we presented our initial experience with laparoscopic procedure.

The aim of this work is to assess the feasibility of laparoscopic gastric fundectomy with grater curvature plication of the remaining part of the stomach for management of morbid obesity, its safety and effect on the weight loss.

PATIENTS AND METHODS

This study included 25 patients with morbid obesity, who were scheduled for laparoscopic gastric fundectomy with greater curvature plication of the remaining part of the stomach. It had been carried out at Damietta University Hospital [Al-Azhar University] from October 2017 to October 2019. We included patients aged 20- 45 years old, who had BMI greater than or equal to 35 kg/m^2, non-sweet eaters, with no endocrinal disturbances, who failed other measures to lose weight, who had no gastroesophageal reflux disease [GERD] or hiatus hernia, and with no previous upper gastrointestinal [GIT] surgery. On the other side, we excluded patients younger than 20 years or older than 45 years of age, who unfit for anesthesia and surgery, sweet eaters, with previous upper GIT surgeries, and who had unmanageable psychological disturbances.

Ethical considerations: Consent was obtained from all patients after explanation of the procedure and expected complications. Approval by Ethical and Medical Committee faculty of medicine, Al-Azhar University [Damietta] was obtained.

All eligible subjects were submitted to:

1. Preoperative assessment [full medical and surgical history taking, weight and height to calculate body mass index [BMI], psychological assessment, assessment of dietary habits of patients and previous trials of weight reduction, and evaluation of associated co-morbidity and treatment medications used [diabetes, hypertension, arthritis and obstructive sleep apnea syndrome]].

2. Laboratory investigations included complete blood picture [CBC], liver function tests [SGPT-SGOT-S. bilirubin- S. albumin], coagulation profile [bleeding time, partial thromboplastin time and international normalization ratio], arterial blood gases [ABG], fasting and post prandial blood glucose, renal function tests [serum creatinine and blood urea], profile functions of thyroid gland, serum cortisol. In addition, imaging studies included

chest X-ray, abdominal ultrasonography and duplex ultrasound to both lower limbs, and upper GIT Endoscopy.

Operative details: Under general anesthesia, patients were positioned in a reverse Trendelenburg position, angled 30° upwards. The camera operator stood on the patient's right side, while the assistant was on the left. The surgeon positioned himself between the patient's legs. A prophylactic dose of one gram of a third-generation cephalosporin was administered. After establishing pneumoperitoneum, five ports were inserted: one 10 mm optical port above the umbilicus, one 12 mm port in the right midclavicular line above the optical port level, one 5 mm port in the left midclavicular line above the optical port level, one 5 mm port below the xiphoid for liver retraction, and one 5 mm port in the left anterior axillary line. The blood supply to the greater curvature of the stomach was divided starting 4-6 cm from the pylorus and continuing upward to the angle of His using a vessel sealing device. Occasionally, posterior gastric adhesions were also cut to ensure optimal mobility [Figure 1].

Fundectomy: Planning of the fundic part which was excised, then fundectomy was performed using a linear stapler with about three sequential blue cartridges. Good hemostasis was obtained with medium sized clips [figure 2].

Greater curvature plication: After removal of the fundus, 32-fr calibrating bougie inserted against lesser curvature to the pylorus then the gastric plication was performed by folding the greater curvature, utilizing a first row of interrupted non-absorbable 0 sutures in a seromuscular fashion to stay clear of gastric acid [Figure 3]. The spacing between the sutures ranged from 1.0 to 1.5 cm. A second row of running non-absorbable 0 sutures was added for reinforcement, ensuring the plication was secure and preventing any herniation between the sutures [Figure 4]. A leak test was conducted by applying pressure on the pylorus and injecting 100 ml of methylene blue through the bougie. One drain was placed in the surgical area, and the port sites were closed with sutures.

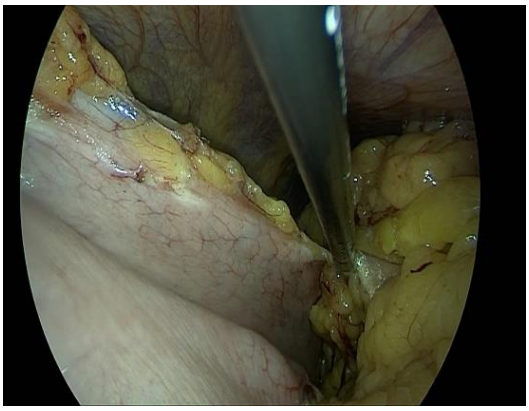

Figure [1]: Devascularization of the greater curvature

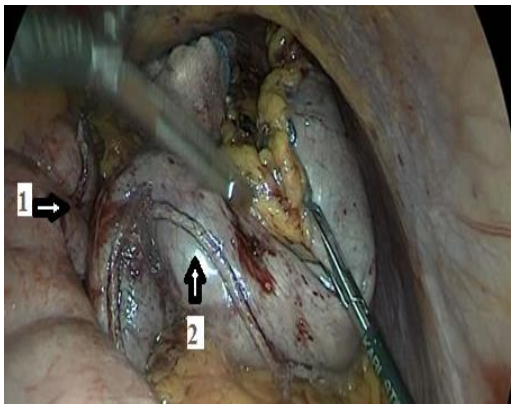

Figure [2]: The appearance of stomach after fundectomy; [1] Stapler line of fundectomy. [2] Removed fundus.

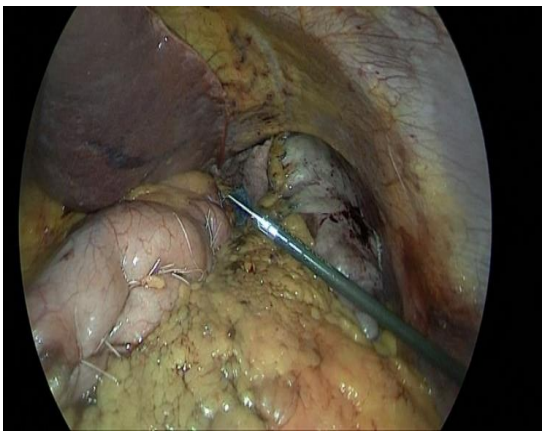

Figure [3]: The first row of greater curvature plication

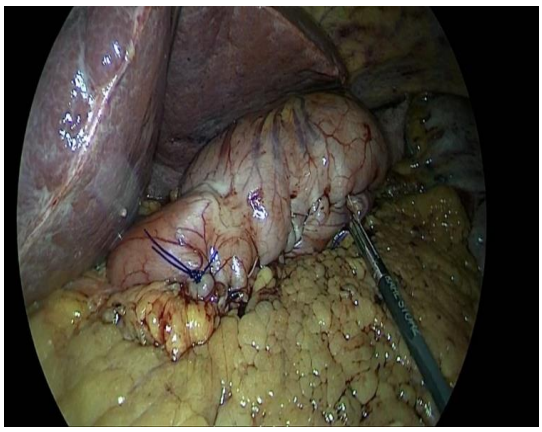

Figure [4]: The final Appearance after Fundectomy with greater curvature plication

Postoperative care: The patient stays in the recovery room for 2-3 hours. One-day admission in the intensive care unit, if needed. Oral intake with sips of clear water was permitted in the day after operation.

The postoperative diet: The postoperative diet was outlined as follows: a tailored liquid diet for the first two weeks, followed by a gradual reintroduction of solid foods in a stepwise manner, with dietary restrictions lifted between 4 to 6 weeks, based on the patient's tolerance. Meticulous management of the patient's diet is essential for effective weight loss. Initially, as with other restrictive approaches, the diet starts with soft liquids like water, milk, and fruit juice [50 cc each for the first two weeks]. In the second stage, patients are advised to avoid sugars in liquids but can consume soft cooked liquids for the following two weeks. The third stage includes thicker liquids such as yogurt and fruits for an additional two weeks. The final stage allows all types of food, with the only limitation being the volume of each meal, capped at four spoonsful. Positive outcomes were linked to reduced carbohydrates and fats while increasing vitamin and protein intake. After one month after operation, the exercise [walking for 60 minutes/ day] was advocated. Usually patients discharge from hospital at the second or third day after surgery.

Postoperative prescription of Proton pump inhibitor for one-month, low molecular weight heparin for one week until full mobilization, good hydration, and avoid sweet eating.

Postoperative follow up: Follow up after one week, one month, three months, six months, one year and two years for assessment of bleeding, gastric leak, stricture, percentage of excess body weight loss [EBW %], effect on comorbid diseases, pulmonary complications, gastroesophageal reflux disease [GERD] and hiatus hernia, vomiting, nutritional impact, wound infection and reoperation.

Outcome: Success was defined as the ability to achieve 40% or more of EBWL percentage; those who fail to achieve this percentage is nominated as failure

Statistical analysis of data: Collected data were presented in appropriate statistics measures [mean, standard deviation, minimum and maximum for quantitative data; frequency a percentage for categorical data]. Repeated analysis of variance was used to examine the effect of intervention at the end of follow up. All were completed by statistical package for social science [SPSS] version 18 [SPSS Inc., USA]. P value < 0.05 was considered significant.

RESULTS

The patient characteristics were presented in table [1]. Males represented 28%, the most common age group was 35 to 45 years [76.0%], the mean age was 37.1±1.2 years. The married patients represented 56%; the onset of obesity in childhood [60.0%] and adulthood [40.0%]. The body mass index ranged between 40 to 54 kg/m^2. Obesity related complications were in the form of diabetes mellitus [DM], hypertension [HTN], arthritis and sleep apnea syndrome [SAS] in 32.0%, 16.0%, 28.0% and 8.0% respectively [Table 1].

The operative time ranged between 90 and 190 minutes; the mean operative time 118.3 ± 29.7 minutes; none of studied patients converted from laparoscopic to open surgery; the hospital stay duration ranged between 1 to 4 days [mean ± SD 1.6±0.78 days]; 8% and 4% were submitted to laparoscopic cholecystectomy and periumbilical hernia repair respectively. The complications were in the form of seroma, port site infection, nausea, persistent vomiting, postoperative bleeding, and cholelithiasis among 8%, 4%, 8%, 16%, and 4% respectively. No one had intraoperative bleeding, stricture, ulcer, or leak [Table 2].

In the current work, there was progressive increase of estimated body weight loss from the first postoperative week till the end of the second year of follow up. In addition, there was improvement of associated comorbidities [hyper-tension was improved or completely disappeared in 3 out of 4 patients, while diabetes improved or disappeared in 6 out of 8 patients, arthritis improved in 3 out of 7 patients and sleep apnea syndrome completely resolved in 2 patients who had SAS [Table 3].

There were two patients [8%] who cannot loss more than [40%] of EBWL% and categorized as failed operation which may be referred to dilatation of the stomach at the part of greater curvature plication, the patient arranged for re-operation for completion of sleeve with bypass. No mortality was occurred at follow up period.

Table [1]: Demographic data and obesity related complications

Variables		Statistics [n=25]
Gender [male/female], n [%]		7/18 [28/72%]
Age [years]	Mean ± SD [range] 20-35 years 35-45	37.1 ± 1.2; 20-45 6 [24.0%] 19 [76.0%]
Marital status [single/married], n [%]		11/14 [44/56%]
Onset of obesity [childhood/adulthood], n [%]		15/10 [60/40%]
Body mass index [mean ± SD]; range		45.7 ± 4.5 [40-54]
Obesity related complications	Diabetes mellitus	8 [32.0%]
	Hypertension	4 [16.0%]
	Arthritis	7 [28.0%]
	Sleep apnea syndrome	2 [8.0%]

Table [2]: Distribution of the studied group according to operative details and complications

Variables		Statistics [n=25]
Operative time [minutes] [mean ± SD; range]		118.3 ± 29.7; 90-190
Conversion to open		0 [0.0%]
Hospital stay [day] [mean ± SD; range]		1.6±0.78; 1-4
Associated procedures	Laparoscopic cholecystectomy	2 [8.0%]
	Para-umbilical hernia repair	1 [4.0%]
Complications	Seroma	2 [8.0%]
	Port site infection	1 [4.0%]
	Nausea	2 [8.0%]
	Persistent vomiting	4 [16.0%]
	Intraoperative bleeding	0 [0.0%]
	Postoperative bleeding	1 [4.0%]
	Stricture	0 [0.0%]
	Ulcer	0 [0.0%]
	Leak	0 [0.0%]
	Cholelithiasis	2 [8.0%]

Table [3]: Estimated body weight loss and improvement of comorbidities at follow up period

	EBWL				HTM	DM	Arthritis	SAS
	Mean	SD	Min.	M.				
First week	0.9	0.6	0.4	1.9	4/25 [16.0%]	8/25 [32.0%]	7/25 [28.0%]	2/25 [8.0%]
First month	7.0	2.6	2.5	10.8	4/25 [16.0%]	7/8 [87.5%]	7/25 [28.0%]	2/25 [8.0%]
Third month	19	4.5	16.5	25.1	4/25 [16.0%]	7/8 [87.5%]	4/7 [57.2%]	2/25 [8.0%]
Six months	38	8.2	33.6	42.7	3/4 [75.0%]	5/8 [62.5%]	4/7 [57.2%]	2/25 [8.0%]
One year	56	11.2	51.7	60.2	2/4 [50.0%]	4/8 [50.0%]	2/7 [28.6%]	0/2 [0.0%]
Two years	62	9.3	53.3	72.7	1/4 [25.0%]	2/8 [25.0%]	4/7 [57.2%]	0/2 [0.0%]
Repeated ANOVA	P < 0.001*							

DISCUSSION

We conducted this study is to evaluate the feasibility of laparoscopic gastric fundectomy with grater curvature plication of the remaining part of the stomach for management of morbid obesity, its safety and effect on weight loss. Results revealed that, the procedure is relatively safe with low complications and excellent results regarding excess weight loss. Females represented the majority of studied subjects [72.0%]. This is in line with **Boza *et al.*** [14]. This could be explained by the fact that, females are more prone to psychosocial problems, and concerned about the cosmetic effects of obesity. Various factors contribute to gender differences in food consumption, with women frequently reporting higher intake of sugary foods compared to men. Additionally, in certain countries, cultural beliefs associate larger body sizes in women with fertility and health. Women are often heavily protected, and cultural or religious constraints can limit their public participation in physical activities. In Egypt, there is also a notable cultural acceptance of increased weight gain among women compared to men [15-16].

In the current work, complication rate appears to be generally low, minor complications as nausea

[8%] and persistent vomiting [16%] are the most common complications. These results are in line with **Chouillard *et al.*** [13] who reported that, nausea and vomiting presented in 20% after laparoscopic greater curvature plication [LGCP] and 7.5% after laparoscopic sleeve gastrectomy [LSG]. The principle difference between LSG and LGCP is the existence of the end luminal fold [17]. In addition, **Skrekas *et al.*** [18] reported that, nausea and/or vomiting are significantly improved after the modified LGCP technique by the construction of a double or triple plication of the apposed gastric wall than the first row of stitches.

In the present work, there was one case with persistent vomiting, which, on reoperation was found to be caused by a single adhesion causing a kink in the plicated stomach, one case of early post-operative leak, which attributed to high endogastric pressure because of persistent vomiting. Comparable results were reported in previous literature [12].

In this study, there was leak among 4% of studied populations. **Rosenthal *et al.*** [19] reported that, gastrointestinal [GI] leak after bariatric surgery is not an uncommon complication and one that can be expected to occur at some point in every bariatric surgeon's experience. The reported incidence in literature varies according to the procedure, LGBP [0.7–5.3%] and for LSG [1.1–7.1%] [20].

The esophagogastric [EG] junction is commonly identified as the usual site for leaks following laparoscopic sleeve gastrectomy [LSG]. Close attention should be paid to this area during stapling. It's crucial to use staples of appropriate height and to avoid stapling the esophagus [21]. **Giuliani *et al.*** [22] noted that acute leaks are the most dangerous complication, potentially leading to fatal outcomes, and there are no standardized protocols for managing them. Leaks typically occur at either the proximal or distal ends of the staple line, with proximal gastric leaks accounting for over 90% of leaks following LSG. **Gagner *et al.*** [23] identified mechanical factors, such as high intragastric pressure from an L-shaped sleeve, physiological pyloric obstruction, hematoma or edema, and the use of a bougie that is too small or reinforcing sutures that create excessive narrowing, as causes of leaks within the first two postoperative days. They also indicated that tissue-related factors can lead to leaks up to six days post-surgery.

In the current study the incidence of post-operative bleeding was 4%. It was reported that the incidence of bleeding after obesity surgery ranges from 0.6 to 3% [24]. The small number of cases could be responsible for exaggerated rate of complications. Stapling a thick, vascular gastric wall may result in significant bleeding both within the lumen and in the surrounding peritoneal cavity.

Regarding EWL, results are of the present study are comparable to previous studies. For examples, one study reported that, the mean EWL of 21.4% at 1 month, 54% at 6 months, 61% at 12 months, 60% at 24 months, and 57% at 36 months [12]. In addition, **t**he mean %EWL was 51.7% at 6 months, 67.1% at 12 months, and 65.2% at 24 months in the publication of **Skrekas *et al.*** [18].

In their series of 42 cases, **Ramos *et al.*** [25] reported a mean %EWL of 20% for the first month, 32% at 3 months, 48% at 6 months, 60% at 12 months, and 62% at 18 months. The result of EWL in this study was much lower than the published studies and we believe that this may be because of the lack of a standard technique for the operation or poor compliance of some of patients to strict adherence of follow-up dietary instructions.

Failure after bariatric surgery in the current study is in line with **Verdi *et al.*** [26] who reported that, insufficient weight loss and were in 60% of cases after LGCP and in 8.8 % of cases after LSG. In addition, **Skrekas *et al.*** [18] reported a failed operation [%EWL<30%] in 6% of patients, and an insufficient weight loss [% EWL <50 %] in greater than 21 % of patients underwent LGCP.

It has been reported that the most frequent causes of death in bariatric surgery are pulmonary embolism, cardiac or respiratory failure and gastric fistula [27]. In the current study, no mortality was occurred at follow up period.

As regard comorbidities, improvement is defined as a decrease in medication use, while resolution refers to the complete elimination of medications and biochemical normalization [28]. In the current study, which focused on weight loss and outcomes for type 2 diabetes, laparoscopic gastric bypass was performed on 55 morbidly obese diabetic patients with a one-year follow-up. After 12 months, the average glycated hemoglobin level was 7.5% [ranging from 5.5% to 8%]. Prior to surgery, all patients were taking oral anti-diabetic medications and none had been living with the disease for more than five years. None of the patients discontinued their diabetes medications after the surgery [29]. However, a published multi-

center international study on the impact of laparoscopic gastric bypass on type 2 diabetes mellitus suggests that the metabolic effects of this procedure fall between those of adjustable gastric banding and sleeve gastrectomy. Thus, laparoscopic gastric bypass appears to be more effective for type 2 diabetes than gastric banding but slightly less effective than sleeve gastrectomy [30]. Hypertension resolution was defined as normal blood pressure [diastolic <80 mmHg and systolic <140 mmHg] in the absence of antihypertensive drugs. In line with this study, reported that 66.7 % hypertension remission after 6 months in LGCP and the improvement was 33.4 % of hypertension 6 months after LGCP [31]. In the terms of sleep apnea syndrome in line with the present study found that the resolution of sleep apnea at 1 year was comparable in both LSG and LRYGB group and the resolution percentage in both groups was 100% [32]. A systematic review revealed that 75% of patients with sleep apnea experienced at least some improvement in their condition following bariatric surgery. Among the various interventions, laparoscopic biliopancreatic diversion [BPD] proved to be the most effective for improving or resolving obstructive sleep apnea, while laparoscopic adjustable gastric banding was the least effective. Improvements were observed regardless of the specific type of sleep apnea [33].

The small number of patients included in the current study is one limiting step which prevents generalization of results and thus, future large-scale studies are warranted. In addition, we compared results with different bariatric procedures due to absence of similar technique in previous studies. However, results of the current work are promising with high efficacy and safety profiles.

In conclusion, laparoscopic gastric fundectomy with grater curvature plication of the remaining part of the stomach in morbid obesity is an effective and relatively safe procedure, with promising results.

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