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Comparison between laparoscopic sleeve gastrectomy versus laparoscopic gastric bypass management of type 2 diabetes mellitus obese patients

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Abstract
Background: Obesity is considered a pan-endemic health problem all over the world. Morbid obesity defined by the National Institutes of Health as a BMI of greater than or equal to 40 kg/m2 or greater than or equal to 35 kg/m2 in the presence of obesity comorbidities like hypertension, type 2 diabetes (T2D), joint pain and obstructive sleep apnea. The aim of this work was to compare between laparoscopic sleeve gastrectomy (SG) versus laparoscopic One Anastemosis gastric bypass management of T2D Obese Patients.
Methods: This prospective study was conducted on 52 people 18-65 years old of both sexes, BMI 30-50 kg/m^2, with T2D, a history of failed weight loss attempts in the past and good motivation for surgery. Included patients were divided into two groups: group I (N=26): obese patients underwent Laparoscopic SG, and group II (N=26): obese patients underwent Laparoscopic Mini Gastric bypass.
Results: The mean random blood sugar after one week, 3 months, 6 months, and 1 year was statistically significant lower in bypass compared SG. The HBA1c after 3 months was remission in (69.23% and 23.08%) patients and no remission in (30.77% and 76.92%) patients between bypass and SG respectively. Thus, it was statistically significant higher in bypass compared to SG.
Conclusions: Gastric bypass was associated with better outcomes compared to SG in diabetes mellitus obese patients. This is observed in more weight loss after 1year, better HbA1c after 3, 6 months and 1 year.

Keywords: Laparoscopic One Anastomosis Gastric bypass, sleeve gastrectomy, type 2 diabetes, obesity

Introduction
Obesity is considered a pan-endemic health problem all over the world. Morbid obesity was defined by the National Institutes of Health as a BMI of greater than or equal to 40 kg/m^2 or greater than or equal to 35 kg/m2 in the presence of obesity comorbidities like hypertension, type 2 diabetes (T2D), joint pain and obstructive sleep apnea. Obesity reduces life expectancy by an average of 3 years, or 8-10 years in the case of severe obesity (BMI over 40) [1].
The potential health benefits of bariatric surgery extend beyond weight management and may include improved survival, remission of T2D diabetes, and reduced incidence of diabetes, cardiovascular disease, and cancers in women. Some forms of bariatric surgery represent metabolic surgery as they primarily alter enteroendocrine hormones, neuronal signaling, beta cell function, and other processes thereby contributing to health benefits, while other procedures only have secondary changes from weight loss [1].
Several randomized trials ensured the truth of bariatric surgery being an effective treatment leading to T2D remission together with durable weight loss mention. Subsequently, bariatric surgery has illuminated the gastrointestinal system as a key pathophysiologic culprit in the development of T2D. Although the literature is inconsistent with the definition of T2D remission, Ribaric and colleagues [3] recently analyzed the remission criteria of each individual study to report an overall remission rate of patients with T2D who underwent bariatric surgery, and compared this with a rate of 15.6% with conventional therapy at a mean follow-up time of 17.3 months. The results of this work indicate that people undergoing bariatric surgery have 9.8 to 15.8 times the odds of reaching diabetes remission compared with conventional therapy. As a result of the collective impact of these studies and the literature, the American Diabetes Association and the International Diabetes Federation have identified bariatric surgery as an effective treatment of T2D [4].

The aim of this work was to compare between laparoscopic SG versus laparoscopic One Anastemosis gastric bypass management of T2D Obese Patients.

Patients and Methods

This prospective study was conducted on 52 people 18-65 years old of both sexes, BMI 30-50 kg/m^2, with T2D, a history of failed weight loss attempts in the past and good motivation for surgery.

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

The following patients were excluded: type 1 diabetics, age less than 15 and more than 65, BMI Less than 30 and more than 55, previous obesity surgery, previous gastric surgery, and females during pregnancy.

Included patients were divided into two groups: group I (N=26): obese patients underwent Laparoscopic SG, and group II (N=26): obese patients underwent Laparoscopic Gastric bypass.

Sleeve gastrectomy

The operation begins with the dissection and removal of the fat pad of the esophagogastric junction, to allow complete visualization of the left face of the left diaphragmatic crus.

Then proceeds to release and ligation of the great gastric curvature with ultrasonic energy (Ultracision Harmonic Ace Plus - Ethicon - Johnson & Johnson Corporation - USA) starting at the distal portion of the gastric body, continuing proximally into the esophagus and subsequently along distal to the pylorus Part of the gastric fundus adhered to the diaphragmatic crus is totally loose in its posterior portion.

Freeing up all the adhesions to complete dissection of the diaphragmatic crus with ligation of the posterior gastric artery, with the entire dissected stomach starts clipping about 2 cm from the pylorus with green load stapler 60 mm using Echelon (Echelon Flex Endopath - Ethicon - Johnson & Johnson Corporation - USA) and without introduction of the gastric tube for this first clipping.

The usual sequence is to follow with a golden cargo and complete the staple line with blue charges, all of 60 mm. From the second shot, all subsequent steps are done with the calibration done by gastric probe number Fr 32 inside the gastric tube, guiding the positioning direction parallel to the stapler.

In the last shot attention to maintain approximately 0.5 to 0.8 cm stomach near the esophagogastric angle to avoid inadvertent clipping of the abdominal esophagus [5].

By conducting the second and third shots, it should be observed carefully the position of the angular notch, thereby avoiding narrowing or rotation of the gastric tube at this point. Before each shot, it must be evaluated properly position the stapler in reference to the anterior and posterior stomach wall to construct fully symmetrical gastric tube.

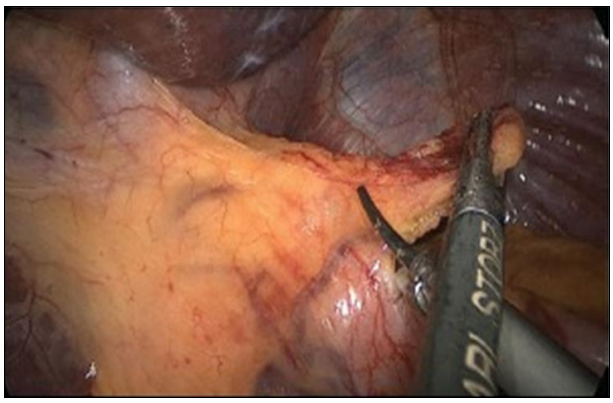

Fig 1: Removal of the fat pad near the esophagogastric junction

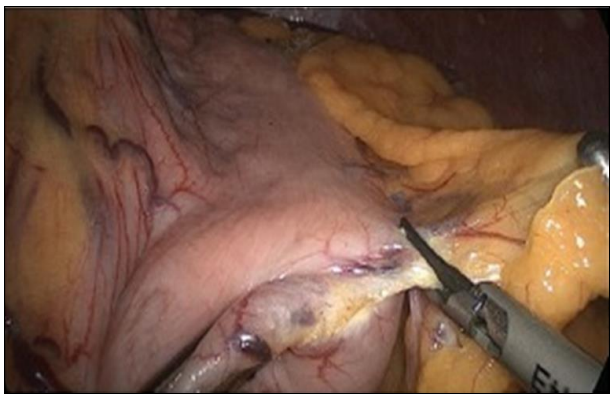

Fig 2: Dissection of the great gastric curvature in the proximal direction to the esophagogastric angle

Upon completion of the stapling and gastric tube production, is carried out continuous suture, transmural and transfixing with absorbable Caprofil(r) 3-0 (Ethicon - Johnson & Johnson Corporation - USA), who started both by the transition, as near the pylorus, with the completion of the suture in the middle portion of gastric tube body. After leak testing of the staple line with methylene blue solution, the stomach is removed by incision of the T3 after digital dilation. This opening is sutured with absorbable Vicryl(r) 0 (Ethicon - Johnson & Johnson Corporation - USA). The abdominal cavity drainage is not performed. After review of hemostasis, surgical gauze and needles counting, the trocars are removed with direct

visualization to evaluate the presence of bleeding in the holes of the portals. The skin is sutured using intradermal separate sutures of Monocryl 4-0 (Ethicon - Johnson & Johnson Corporation - USA) and the dressing is made by applying an adhesive solution to skin (Dermabond(r) - Ethicon - Johnson & Johnson Corporation - USA).

Surgical technique for Laparoscopic Mini Gastric bypass

Setup and entrance into the peritoneal cavity: The abdomen is prepped and draped in standard sterile fashion. The operating surgeon was stranded on the patient's right side along with the scrub technician. Entrance into the abdomen is obtained in the left upper quadrant with both verses insufflation and 12mm optical trocar placement or open technique with subsequent placement of a 12 mm trocar and insufflation of the abdomen to 15 mm Hg. A 10 mm 30-degree scope is then placed in the left upper quadrant and once safe entry is confirmed the abdomen may be visually inspected. A 10 mm supra umbilical port is placed under direct visualization.

Creation of the gastric pouch: Now the patient will be placed in steep reverse Trendelenburg position to facilitate the creation of the gastric pouch. Next, the gastric pouch is ready to be created. The optimal staple height for the stomach should be 3.8-4.1mm. A bougie should be placed by anaesthesia. The first staple firing should be horizontal across the stomach at the level of incisura. The subsequent staple firing is then oriented vertically toward the angle of His along the inserted bougie. This should create a proximal gastric pouch completely removed from the distal alimentary tract and should be approximately 15 to 30 cc.

After Creation of a narrow long pouch after partial transection of the stomach at the level of incisura angularis. Now the greater omentum is elevated along with the transverse colon to expose the ligament of Treitz. The jejunum is elevated after counting the whole length of the intestine and performing a Gastrojejunostomy 200 cm far from DJ flexure. Some may mark this point with a suture to avoid confusion later in the surgery [6]. The Primary end point was the remission of diabetes with hyperglycemia control. Weight loss is by calculating the percentage of excess weight loss (% EWL) or the percentage of excess BMI lost. The percentage of excess weight loss (%EWL) was defined as (weight lost/pre-operative weight – ideal body weight) X 100. Ideal body Weight is equal to body weight at BMI 25.

Statistical analysis

Data was analyzed using STATA version 14.2 (Stata Statistical Software: Release 14.2 College Station, TX: StataCorp LP.). Quantitative data was represented as mean, standard deviation, median and range. Data was analyzed using student t-test to compare the means of two groups and ANOVA for comparison of the means of three groups or more. Qualitative data was presented as number and percentage and compared using either Chi square test or fisher exact test. Graphs were produced by using Excel or STATA program. P value was considered significant if it was less than 0.05.

Results

The mean age was 41.63±7.6 in the studied patients. Gender was 63.46% females and 36.54% males. Marital status was 76.92% married and 23.08% single. Residence was 75.00% in Sohag, 11.54% in Qena, 7.69% in Assuit, 1.92% in China, 1.92% in Saudia Arabia and 1.92% in United Arab Emirates. All participants had diabetes mellitus. There were 71.15% patients who had hypertension. There were 90.38% patients who had ischemic heart disease. Previous surgeries were 30.77% CS, 7.69% oblique hernioplasty, 5.77% CS-cholecystectomy, 3.84% par umbilical herniplasty, 1.92% breast fibroadenoma excision, 1.92% cholecystectomy, 1.92% discectomy, 1.92% thyroidectomy and 1.92% urinary bladder stones. There were 94.23% patients who had previous diet. There were 5.77% patients who failed trails. There were 3.85% patients who had previous deep vein thrombosis. There were 76.92% who had gall bladder stone. (Table 1)

Table 1: Personal and medical history of studied population

Variable	Summary statistics
Age/year	
Mean ± SD	41.63±7.61
Median (range)	41(25:56)
Gender	
Female	33 (63.46%)
Male	19 (36.54%)
Marital status	
Married	40 (76.92%)
Single	12 (23.08%)
Residence	
Sohag	39 (75.00%)
Qena	6 (11.54%)
Assuit	4 (7.69%)
China	1 (1.92%)
Saudia Arabia	1 (1.92%)
United Arab Emirates	1 (1.92%)
Diabetes	
No	0
Yes	52 (100%)
Hypertension	
No	37 (71.15%)
Yes	15 (28.85%)
Ischemic heart disease	
No	47 (90.38%)
Yes	5 (9.62%)

Previous surgery	
No	22 (42.31%)
CS	16 (30.77%)
Oblique hernioplasty	4 (7.69%)
CS-cholecystectomy	3 (5.77%)
Par umbilical herniplasty	2 (3.84%)
Breast fibroadenoma excision	1 (1.92%)
Cholecystectomy	1 (1.92%)
Discectomy	1 (1.92%)
Thyroidectomy	1 (1.92%)
Urinary bladder stones	1 (1.92%)
Previous diet	
No	3 (5.77%)
Yes	49 (94.23%)
Previous exercise	
Failed trails	52 (100%)
Previous deep vein thrombosis	
No	50 (96.15%)
Yes	2 (3.85%)
Gall bladder stone	
No	12 (23.08%)
Yes	40 (76.92%)

The type of surgery was mini bypass in 50% patients and SG in 50% patients. (Figure 3)

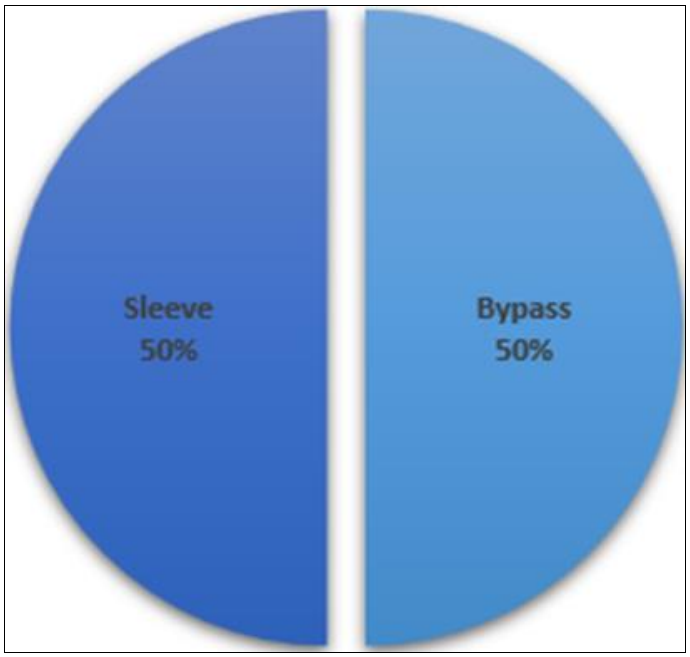

Fig 3: Type of surgery done

The mean weight was 119.85±14.10 and 125.31±12.3.5 between bypass and SG respectively. There was no statistically significant difference between bypass and SG. The mean height was 163.65±6.66 and 163.58±4.72 among bypass and SG respectively. There was no statistically significant difference between bypass and SG. The mean BMI was 45.62±6.71 and 47.9±4.69 between bypass and SG respectively. There was no statistically significant difference between the bypass and SG. (Table 2)

Table 2: Comparison between bypass and sleeve gastrectomy surgery as regard preoperative anthropometric measures

Variable	Bypass N=26	Sleeve gastrectomy N=26	P value
Weight/kg			
Mean± SD	119.85±14.10	125.31±12.3.5	0.13
Median (range)	117 (99:158)	123.5 (109:154)	
Height /cm			
Mean± SD	163.65±6.66	163.58±4.72	0.96
Median (range)	161.5 (150:176)	163 (157:177)	
BMI			
Mean± SD	45.62±6.71	47.9±4.69	0.20
Median (range)	45 (37:65)	47 (41:60)	

The mean HbA1C was 8.30±0.71 and 7.72±0.57 between bypass and SG respectively. There was a statistically significant difference between the bypass and SG. All participants had HBA1c > 6 in bypass and SG. (Table 3)

Table 3: Comparison between bypass and Sleeve surgery as regard preoperative HBA1c

Variable	Bypass N=26	Sleeve gastrectomy N=26	P value
HBA1c			
Mean±SD	8.30±0.71	7.72±0.57	
Median (range)	8.2 (7:9.5)	7 (7:9)	0.002*
HBA1c >6	26 (100%)	26 (100%)	---

The mean weight after 2 weeks was 118.08±17.61 and 116.77±12.95kg bleeding between bypass and SG respectively. There was no statistically significant difference between bypass and SG. Regarding to the mean weight after 4 weeks was 109.04±16.16 and 110.65±12.71 between bypass and SG respectively. There was no statistically significant difference between bypass and SG. The mean weight after 1 year was 61.69±5.14 and 72.42±7.71 between bypass and SG respectively. There was a statistically significant difference between the bypass and SG. The mean percentage of weight loss after 1 year was 90.77±3.92 and 69.62±12.24 between bypass and SG respectively. There was a statistically significant difference between the bypass and SG. (Table 4)

Table 4: Comparison between bypass and sleeve gastrectomy surgery as regard post-operative weight

Variable	Bypass N=26	Sleeve gastrectomy N=26	P value
Weight after 2 weeks			
Mean ± SD	118.08±17.61	116.77±12.95	0.76
Median (range)	115.5(90:148)	113 (100:141)	
Weight after 4 weeks			
Mean ± SD	109.04±16.16	110.65±12.71	0.69
Median (range)	106 (85:139)	107.5 (94:133)	
Weight after 1 year			
Mean ± SD	61.69±5.14	72.42±7.71	<0.0001*
Median (range)	61 (53:70)	73 (60:90)	
Percentage of weight loss after 1 year			
Mean ± SD	90.77±3.92	69.62±12.24	<0.0001*
Median (range)	90 (80-95)	67.5 (50:90)	

The mean random blood sugar after one week was 104.23±12.44 and 130.42±15.44 between bypass and SG respectively. There was a statistically significant difference between the bypass and SG. The mean HBA1c after 3 months was 5.81±0.7 and 6.63±0.5 between bypass and SG respectively. There was a statistically significant difference between the bypass and SG. The HBA1c after 3 months was remission in (69.23% and 23.08%) patients and no remission in (30.77% and 76.92%) patients between bypass and SG respectively. The mean HBA1c after 6 months was 5.24±0.31 and 5.86±0.46 between bypass and SG respectively. There was a statistically significant difference between the bypass and SG. HBA1c after 6 months all participants were remission in bypass, 80.77% patients were remission in SG and 19.23% no remission in SG. There was no statistically significant difference between bypass and SG. The mean HBA1c after 1 year was 4.82±0.25 and 5.52±0.49 between bypass and SG respectively. There was a statistically significant difference between the bypass and SG. HBA1c after 1 year all participants were remission in bypass, 96.15% remission in SG and 3.85% no remission in SG. There was no statistically significant difference between bypass and SG. (Table 5).

Table 5: Comparison between bypass and sleeve gastrectomy surgery as regard postoperative blood sugar and HBA1c

Variable	Bypass N=26	Sleeve gastrectomy N=26	P value
Random blood sugar after one week			
Mean±SD	104.23±12.44	130.42±15.44	<0.0001
Median (range)	100 (92:150)	134.5 (90:150)	
HBA1c after 3 months			
Mean±SD	5.81±0.7	6.63±0.5	<0.0001
Median (range)	5.95 (4.9:6.9)	6.65 (5.9:7.5)	
HBA1c after 3 months			
Remission	18 (69.23%)	6 (23.08%)	0.001
No remission	8 (30.77%)	20 (76.92%)	
HBA1c after 6 months			
Mean±SD	5.24±0.31	5.86±0.46	<0.0001
Median (range)	5 (4.9:5.9)	5.9 (5:7)	
HBA1c after 6 months			
Remission	26 (100%)	21 (80.77%)	0.051
No remission	0	5 (19.23%)	
HBA1c after 1 year			
Mean±SD	4.82±0.25	5.52±0.49	<0.0001
Median (range)	4.9 (4.5:5.5)	5.5 (4.5:6.5)	
HBA1c after 1 year			
Remission	26 (100%)	25 (96.15%)	1.00
No remission	0	1 (3.85%)	

Discussion

In the current study, the mean HbA1C was 8.30±0.71 and 7.72±0.57 between bypass and SG respectively. There was a statistically significant difference between the bypass and SG. All participants had HBA1c > 6 in bypass and SG.

On the other hand, Abd-Elmonem *et al.* [7] reported that there was no statistically significant difference between bypass and SG regarding baseline HbA1C.

The present study showed that the mean weight after 2 weeks was 118.08±17.61 and 116.77±12.95 bleeding between bypass and SG respectively. There was no statistically significant difference between bypass and SG. The mean weight after 4 weeks was 109.04±16.16 and 110.65±12.71 between bypass and SG respectively. There was no statistically significant difference between bypass and SG. The mean weight after 1 year was 61.69±5.14 and 72.42±7.71 between bypass and SG respectively. There was a statistically significant difference between the bypass and SG. The mean percentage of weight loss after 1 year was 90.77±3.92 and 69.62±12.24 between bypass and SG respectively. There was a statistically significant difference between the bypass and SG.

Similarly, Elkerkary *et al.* [8] reported that among the SG group, the mean preoperative BMI was 53 kg/m2, it decreased to 50.6 kg/m^2 one month after surgery, then to 49.6 kg/m2 after 3 months, 45.5 kg/m2 after 6 months, 40 kg/m2after 9 months, and finally 37 kg/m2 at the end of follow-up 12 months after surgery. Regarding bypass group, the mean preoperative BMI was 52 kg/m2, it decreased to 48.1 kg/m2 1 month after surgery, then to 43.2 kg/m2after 3 months, 40 kg/m2 after 6 months, 37.4 kg/m2 after 9 months, and finally 35.1 kg/m2 at the end of follow-up 12 months after surgery. The difference in the perioperative changes in the mean BMI between the study groups was statistically significant.

On the other hand, Mohamed *et al.* [9] reported that SG group was associated with more weight loss at 1 month, and 3 months while there was no significant difference at 9 and 12 months.

In the current study, the mean random blood sugar after one week was 104.23±12.44 and 130.42±15.44 between bypass and SG respectively. There was a statistically significant difference between the bypass and SG. The mean HBA1c after 3 months

was 5.81±0.7 and 6.63±0.5 between bypass and SG respectively. There was a statistically significant difference between the bypass and SG. The HBA1c after 3 months was remission in (69.23% and 23.08%) patients and no remission in (30.77% and 76.92%) patients between bypass and SG respectively. The mean HBA1c after 6 months was 5.24±0.31 and 5.86±0.46 between bypass and SG respectively. There was a statistically significant difference between the bypass and SG. HBA1c after 6 months all participants were remission in bypass, 80.77% patients were remission in SG and 19.23% no remission in SG. There was no statistically significant difference between bypass and SG. The mean HBA1c after 1 year was 4.82±0.25 and 5.52±0.49 between bypass and SG respectively. There was a statistically significant difference between the bypass and SG. HBA1c after 1 year all participants were remission in bypass, 96.15% remission in SG and 3.85% no remission in SG. There was no statistically significant difference between bypass and SG.

Similarly Abd-Elmonem *et al*. [7] reported that bypass has a better effect than SG in diabetes remission detected by that the mean fasting blood glucose drop after one year in bypass (37.80 ± 6.41 mg/dl) was more than after SG (29.93 ± 12.84 mg/dl) and this difference of drop was highly statistically significant (p value <0.004).

In agreement with the present findings, Elmary *et al*. [8] reported that concerning the primary outcome, among the SG group, the mean preoperative HbA1c was 10.1%, it decreased to 8.6% 3 months after surgery, then to 8.1% after 6 months, 7.4% after 9 months, and finally 7% at the end of follow-up 12 months after surgery. Regarding bypass group, the mean preoperative HbA1c was 10.9%, it decreased to 8.1% 3 months after surgery, then to 7.2% after 6 months, 6.9% after 9 months, and finally 6.6% at the end of follow-up 12 months after surgery. The difference in the perioperative changes in the mean HbA1c between the study groups was statistically significant.

Limitations of the study include being a single-center study which may have different results from other studies. Small sample size is also considered a limitation and short follow-up period for complications. Sample size is required to be larger in further studies to produce more accurate results as well as multi-center studies are recommended. Close monitoring of complications occurrence with the increase of follow-up period.

Conclusions

Gastric bypass was associated with better outcomes compared to SG in diabetes mellitus obese patients. This is observed in more weight loss after 1-year, better HbA1c after 3, 6 months and 1 year.

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Nil

Conflict of Interest

Nil

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