Obesity Surgery (2019) 29:3103–3110
https://doi.org/10.1007/s11695-019-03991-5

ORIGINAL CONTRIBUTIONS

Conventional Versus Distal Laparoscopic One-Anastomosis Gastric Bypass: a Randomized Controlled Trial with 1-Year Follow-up

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Published online: 8 June 2019

Abstract

Background There is no consensus on the ideal small bowel length that should be bypassed in laparoscopic one-anastomosis gastric bypass (OAGB). This study aimed to compare the safety and efficacy of conventional versus distal techniques of laparoscopic OAGB.

Methods This randomized controlled trial involved 60 adults with morbid obesity scheduled for laparoscopic OAGB randomly assigned to one of the two techniques; conventional technique (fixed anastomosis 200 cm from the ligament of Treitz) and distal technique (anastomosis 400 cm from the ileocecal valve). Total small bowel length (TSBL) was measured in all cases. Quality of life was assessed using the Gastrointestinal Quality of Life Index (GIQLI). Outcome measures were excess body weight loss percentage (EBWL%), resolution of associated comorbidities, frequency of nutritional deficiencies, and quality of life.

Results No patients were lost to follow-up. The two groups were comparable in TSBL, EBWL%, and complete resolution of comorbidities up to 12 months. The percentage of afferent loop length to TSBL was significantly higher in the distal group ($p < 0.001$) but was not correlated with EBWL%. The levels of hemoglobin, cholesterol, triglycerides, iron, and albumin were significantly lower and parathormone hormone was higher in the distal group. The GIQLI score was significantly higher in the conventional group during follow-up.

Conclusion OAGB achieves optimum results when the afferent loop length is 200 cm; bypassing more than 200 cm does not improve weight loss or comorbidity resolution. Measuring TSBL is recommended to avoid excessive small bowel shortening that increases the risk of nutritional consequences.

Keywords Bariatric surgery · Morbid obesity · Afferent loop length · Total bowel length · Nutritional deficiency

Introduction

Roux-en-Y gastric bypass (RYGB) is a mixed procedure that has been considered the "gold standard" of bariatric surgery [1]. However, it is a technically demanding procedure with relatively high morbidity. Laparoscopic one-anastomosis gastric bypass was introduced as a simple and effective procedure [2]. On one hand, it is restrictive because of the creation of a gastric reservoir, and on the other hand, it is malabsorptive as a segment of the small intestine is bypassed. In addition, endocrine changes appear to be involved in the mechanism of action of OAGB [3].

Original description of the procedure implies the creation of a loop gastroenterostomy with the small bowel about 200 cm distal to the ligament of Treitz [2]. Surgeons measure the bowel limbs from the ligament of Treitz. Nevertheless, there is currently no consensus on the ideal small bowel length that should be bypassed and on the relative proportion of the afferent loop length to the total small bowel length (TSBL) [4].

Therefore, in the current study, we compare two techniques of laparoscopic OAGB, the conventional technique involving fixed gastro-enteric anastomosis 200 cm from the ligament of Treitz and the distal technique of fixed gastro-enteric anastomosis 400 cm from the ileocecal valve (ICV), regarding

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weight loss, nutritional deficiencies, quality of life (QOL), and the resolution of obesity-related comorbidities.

Patients and Methods

This randomized control trial (RCT) was conducted in two university hospitals between April 2016 and December 2018 after obtaining approval from the institutional review boards and ethical committees of the two hospitals. The study involved 60 patients suffering from morbid obesity scheduled for laparoscopic OAGB. After explaining the study procedure, the techniques, the possible side effects, and outcome which may be favorable, an informed consent was obtained from each participant before surgery.

Inclusion criteria were morbid obesity defined as body mass index (BMI) 40 kg/m^2 or > 35 kg/m^2 associated with obesity-related comorbidities, and acceptable operative risks in patients 18–65 years old. Obesity-related comorbidities included T2D, hypertension, hyperlipidemia, bronchial asthma, osteoarthritis, and degenerative joint disease.

All patients should have previously failed conservative treatment program for at least 6 months. Also, the ability to comply with nutritional supplementation and long-term follow-up was assured. Patients with previous abdominal surgery related to the gastrointestinal tract (GIT), endocrine disorders causing obesity as hypothyroidism and Cushing disease, pregnancy or lactation, psychiatric illness, or recent diagnosis of malignancy were excluded from the study. Also, patients with total small bowel length (TSBL) < 600 cm are excluded from the study for fear of unsatisfactory weight loss if they were included in the distal group as the bypassed afferent limb will be less than 200 cm and to avoid major nutritional deficiency if they were included in the conventional group.

The participants were randomly assigned to one of two equal groups according to the operative techniques using computer-generated permuted blocks (www.randomization.com). Informed consent was obtained from each patient before being enrolled in the study. In the conventional group ($n = 30$) , gastro-enteric anastomosis was performed at a fixed length 200 cm from the ligament of Treitz. In the distal group ($n = 30$), gastro-enteric anastomosis was performed at 400 cm from the ICV. Details of enrollment procedure are shown in Fig. 1.

All patients were subjected to full history taking and clinical examination. Baseline body mass index (BMI) was calculated. Routine laboratory investigations were done in addition to measurement of serum iron, calcium, parathormone, total proteins, and albumin. In addition, cardiopulmonary assessment, abdominal ultrasound, and upper GIT endoscopy were performed. Preoperatively, all patients were put on a low-calorie (800–1000 Kcal/day) high-protein diet with micronutrients and vitamins for those having nutritional deficiency before surgery for 2 weeks.

Surgical Technique

Total small bowel length (TSBL) was measured in all patients of both groups. The percentage of afferent loop length (AL) to total small bowel length (AL/TSBL) was calculated in all patients of both groups. The omentum was retracted medially, and the ligament of Treitz was identified and the small bowel was run to the ileocecal valve (ICV). Bowel measurement was done along a 10-cm nylon tape along anti-mesenteric border of non-stretched bowel (Fig. 2). Bowel measurements were achievable with the surgeon standing between patient's legs. Change of patients to Trendelenburg position with a right tilt was sometimes needed to reach the ileocecal junction. There was no need to change the camera port in all patients included in the study. Putting the two main working ports at a slightly lower level than usual facilitates the measurements. Patients in whom total small bowel measurement was not achievable were excluded from the study (two cases).

In the conventional group, fixed gastro-enteric anastomosis was done 200 cm from the ligament of Treitz. In the distal group, fixed gastro-enteric anastomosis was done 400 cm from the ICV, but afferent loop should be more than 200 cm. In both groups, the gastric pouch was sized using a 36Fr bougie.

Postoperative Management and Follow-up

During the first 2 weeks, all patients were placed on a liquid-only diet. This was then advanced to a semi-solid diet for 2 weeks followed by mashed food for another 2 weeks. After that, a regular healthy diet was started. A supplementation regimen was prescribed including daily pills of calcium citrate 1000 mg and multivitamins containing post-bariatric surgery recommended doses of vitamins and minerals which include 60 mg of iron. A high-protein diet with at least 70 g daily was emphasized and in first 3 months at least by using protein supplements.

Postoperative follow-up visits were scheduled 1 week and 1 month after surgery then at 3, 6, and 12 months. At each visit 3, 6, and 12 months after surgery, the patients were evaluated regarding actual weight and BMI, the percentage of excess body weight loss (EBWL%), and laboratory tests to detect the resolution of obesity-related comorbidities and some nutritional deficiencies. These tests included complete blood count (CBC), fasting blood glucose (FBG), kidney and liver function tests, lipid profile, serum iron, calcium (total and ionized), parathormone, total proteins, and albumin. The resolution of obesity-related comorbidities and nutritional deficiency were assessed 12 months after surgery. Hemoglobin (Hb) deficiency was diagnosed if hemoglobin concentration was < 12 g/dL. Iron deficiency was diagnosed if its level was < 40 μg/dL in females, or < 55 μg/dL in males. Calcium deficiency was diagnosed when

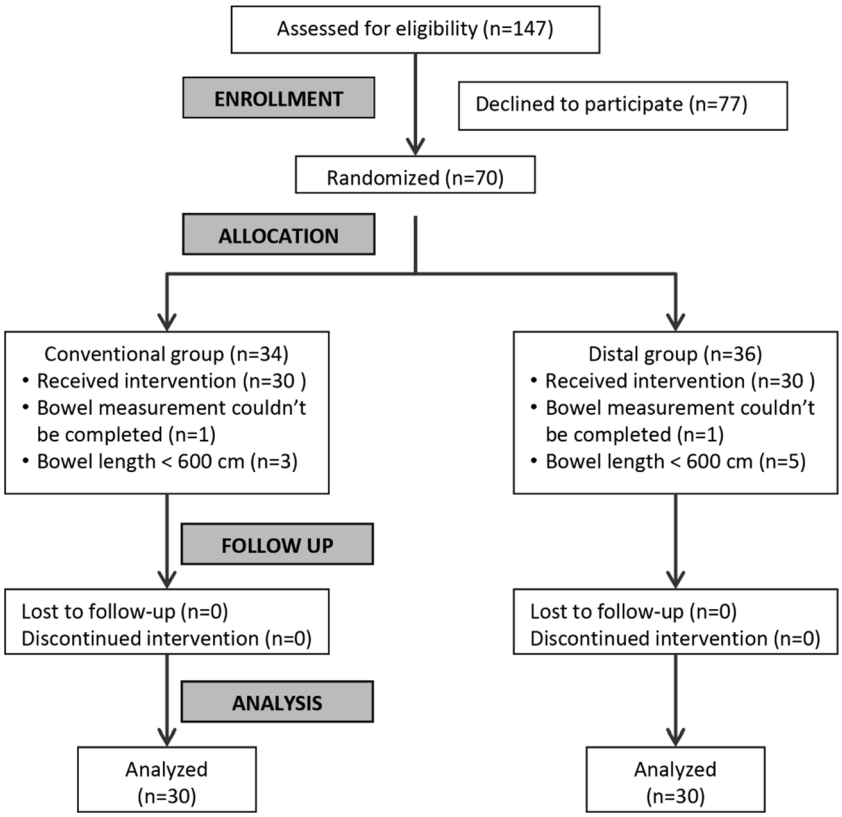

Fig. 1 CONSORT diagram

its level was < 8.5 mg/dL. Hypoalbuminemia was diagnosed when the albumin level was < 3 g/dL.

Quality of life was assessed using a translated version of the Gastrointestinal Quality of Life Index (GIQLI) [5] after surgery at 3, 6, and 12 months. A 36-item questionnaire was used in previous bariatric surgery studies. Each item is quoted from 0 to 4; scores range from 0 to 144, with higher scores indicating better function. The questionnaire measures 5 principal domains: upper gastrointestinal symptoms (12 items), lower gastrointestinal symptoms (7 items), physical status (7 items), psychological status (5 items), and social status (5 items).

The primary outcome measure was the %EBWL and resolution of obesity-associated comorbidities. The secondary outcome measures were the frequency of nutritional deficiency and quality of life.

Statistical Analysis

Statistical analysis was performed with IBM1® SPSS® Statistics Version 23 for Windows. Numerical data were expressed as mean and standard deviation (SD) and range. Qualitative data were expressed as frequency and percentage. The chi-square (Fisher's exact) test was used to examine the relation between qualitative variables to test for proportion independence as appropriate. Paired comparisons of categorical variables were done by McNemar's test. Testing for normality was checked by the Shapiro-Wilk test of normality and the Kolmogorov-Smirnov test of normality. Paired comparisons of numerical variables were done by paired *t* test. Comparison between numerical variables in the two groups was done using the *t* test of the Mann-Whitney *U* test as

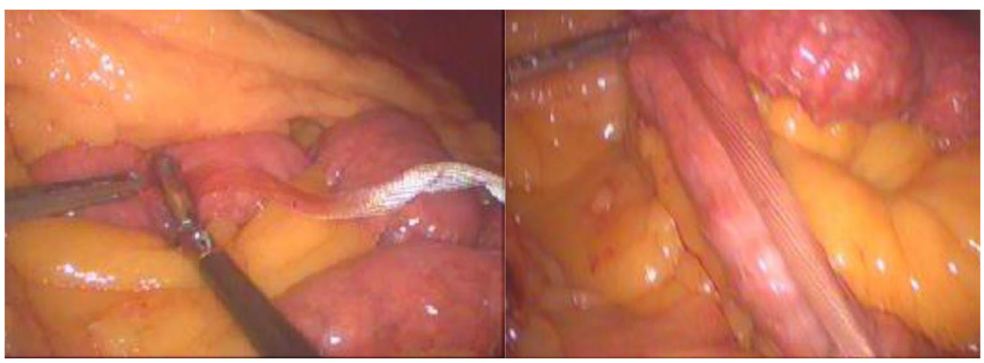

Fig. 2 Measurement of total small bowel length (TSBL) using a 10-cm nylon tape along the antimesenteric border of non-stretched small bowel

appropriate. Correlation analysis was performed using the Pearson correlation. The significance level was set at $p < 0.05$.

Results

Table 1 shows that the two groups were comparable regarding age, sex, and baseline weight, height, and BMI. Most patients were super-obese (BMI ≥ 50 kg/m^2), with no significant difference between the two groups. Similarly, there was no significant difference between the two groups in the baseline laboratory characteristics (Table 2) and the frequency of obesity-related comorbidities (Table 3).

As shown in Table 4, there was no significant difference between the two studied groups regarding TSBL. But, the AL/TSBL was significantly higher in the distal group ($p < 0.001$). In the whole studied group ($n = 60$), TSBL was not correlated with age and BMI (Table 5), but, it was positively correlated with baseline weight ($r = 0.474$) and height ($r = 0.314$).

Body weight and BMI decreased significantly 3, 6, and 12 months after surgery compared with the baseline weight and BMI in the two studied groups ($p < 0.001$, for all comparisons). No significant difference was found between the two groups in the actual weight and BMI during the follow-up visits at 3, 6, and 12 months. Similarly, percentages of excess body weight loss (EBWL%) were comparable up to 12 months after surgery (Table 6). No significant correlation was found between AL/TSBL% and %EBWL during follow-up visits 3, 6, and 12 months after surgery in all studied patients (Table 7).

One year after surgery, the levels of Hb, serum cholesterol, triglycerides, iron, total proteins, and albumin were significantly lower in the distal group (Table 8). The levels of SGOT and parathormone were significantly higher in the distal group. There was no significant difference in the other laboratory items between the two groups (Table 8). Before surgery, there was no significant difference between the two groups in the frequency of hemoglobin or iron deficiency and none of the patients had calcium deficiency or hypoalbuminemia (Table 9). After surgery, Hb deficiency increased significantly in the distal group ($p < 0.001$), but not in the conventional group ($p = 0.063$); thus, Hb deficiency became significantly higher in the distal group ($p = 0.002$). Similar changes occurred in iron deficiency; it became significantly more frequent in the distal group ($p < 0.001$). Eleven patients of the distal group developed hypoalbuminemia 12 months after surgery compared with two of the conventional group ($p = 0.005$). The AL/TSBL in patients with hypoalbuminemia at the end of follow-up was 47.3 ± 6.4% and that in those with normal albumin level was 35.5 ± 9.0% ($p < 0.001$).

Preoperative obesity-related comorbidities significantly improved in all patients of the two groups who had comorbidities. There was no significant difference between the two groups regarding the complete resolution of comorbidities at 12 months after surgery (Table 10). The gastrointestinal quality of life index (GIQLI) score at follow-up visits 3, 6, and 12 months after surgery was significantly higher in the conventional group (Table 11). The percentage of afferent loop length to TSBL was negatively correlated with the gastrointestinal quality of life index (GIQLI) score in all studied patients at follow-up 3, 6, and 12 months after surgery (Table 12).

Table 1 Baseline characteristics of the two studied groups

	Conventional group ($n = 30$)	Distal group ($n = 30$)	p value
Age (years)	37.4 ± 10.2	39.1 ± 10.5	0.520
Sex (female/male)	26/4	24/6	0.488
Weight (kg)	141.7 ± 23.9	142.3 ± 26.6	0.929
Height (cm)	163.3 ± 6.6	162.9 ± 9.3	0.862
Body mass index (kg/m^2)	52.2 ± 9.7	54.9 ± 9.2	0.281
Super-obese	20 (66.7%)	22 (73.3%)	0.573

Data are presented as mean ± SD, ratio, or number (%)

Discussion

This study demonstrated that in laparoscopic OAGB, bypassing the proximal 200 cm of small bowel or leaving the distal 400 cm active was similarly effective regarding weight reduction and resolution of obesity-related

Table 2 Baseline laboratory characteristics of the two studied groups

	Conventional group ($n = 30$)	Distal group ($n = 30$)	p value
Hemoglobin (g/dL)	12.9 ± 1.2	12.7 ± 1.0	0.568
Serum iron (mcg/dL)	59.8 ± 17.2	54.9 ± 21.9	0.343
Serum calcium (mg/dL)	8.8 ± 0.6	8.8 ± 0.4	0.753
Parathormone (ng/L)	36.0 ± 15.2	34.0 ± 19.7	0.661
Serum total proteins (g/dL)	6.8 ± 0.6	7.0 ± 0.5	0.247
Albumin (g/dL)	3.7 ± 0.3	3.7 ± 0.4	0.562
Blood urea (mg/dL)	24.8 ± 5.7	27.8 ± 6.1	0.050
Serum creatinine (mg/dL)	0.8 ± 0.2	0.8 ± 0.1	0.613
Fasting blood glucose (mg/dL)	136.1 ± 58.0	135.9 ± 58.1	0.989
Serum cholesterol (mg/dL)	222.0 ± 39.3	230.8 ± 54.2	0.475
Serum triglycerides (mg/dL)	149.2 ± 48.9	138.0 ± 37.4	0.358
SGPT (U/L)	32.6 ± 11.0	35.0 ± 21.8	0.625
SGOT (U/L)	25.5 ± 9.4	28.3 ± 15.9	0.404

Data are presented as mean ± SD, ratio

SGPT serum glutamic pyruvic transaminase, *SGOT* serum glutamic-oxaloacetic transaminase

Table 3 Preoperative obesity-related comorbidities in both groups

	Conventional group ($n = 30$)	Distal group ($n = 30$)	p value
Type-2 diabetes mellitus	14 (46.7%)	16 (53.3%)	0.606
Hypertension	10 (33.3%)	9 (30.0%)	0.781
Hyperlipidemia	23 (76.7%)	21 (70.0%)	0.559
Bronchial asthma	1 (3.3%)	3 (10.0%)	0.612
Osteoarthritis	13 (43.3%)	19 (63.3%)	0.121

Data are presented as number (%)

comorbidities up to 12 months postoperatively. The percentage of excess body weight loss was not correlated with the percentage of afferent loop length relative to the TSBL. The distal group showed significantly lower hemoglobin, iron, and albumin with significantly higher parathormone levels 1 year after surgery compared with the conventional group. This high parathormone level was treated with increasing doses of calcium to 1800–2000 mg of elemental calcium in form of calcium citrate and an increasing dose of vitamin D3 to 5000–15,000 IU daily with a target of 25 hydroxyvitamin D less than 100 but more than 30 ng/ml. Bone densitometry will be done for all cases after 24 months and treatment will be started for osteoporosis if indicated. The gastrointestinal quality of life index (GIQLI) score at follow-up visits was significantly higher in the conventional group. It was negatively correlated with the percentage of afferent loop length to TSBL.

Ever since Robert Rutledge performed the first OAGB, many variations and a series of modifications to the length of the bypassed limb have been suggested to improve weight loss and reduce protein malnutrition. However, there is currently no consensus on ideal limb lengths. During talking about how much length to bypass, an important question should be answered about the whole length of the small bowel. The length of small intestine

Table 4 Total small bowel length and the percentage of afferent loop length to total small bowel length in the two studied groups

	Conventional group ($n = 30$)	Distal group ($n = 30$)	p value
Total small bowel length (cm)			
Mean ± SD	715 ± 123	728 ± 103	0.641
Range	600–950	620–1000	
The afferent loop length (cm)			
Mean ± SD	200*	301 ± 104	
Range		220-600	
Afferent loop length/total length (%)			
Mean ± SD	28.4 ± 7.1	44.2 ± 7.8	< 0.001
Range	21.0–33.3	35.5–60.0	

*The length is fixed at 200 cm in the conventional group

Table 5 Correlation between the total small bowel length and age, height, weight, and BMI in the whole studied group ($n = 60$)

	Total small bowel length	
	Correlation coefficient (r)	p value
Age (year)	0.182	0.164
Height (cm)	0.314	0.014
Baseline weight (kg)	0.474	< 0.001
Baseline BMI (kg/m^2)	0.267	0.133

varies greatly between 300 and 1000 cm among patients [6]. Therefore, it is possible to find small bowel as short as 300 cm in some patients. Routinely bypassing 200 cm of small bowel without any consideration of TSBL may, hence, put some patients at risk of malnutrition.

In the present study, we adopted routine measurement of the TSBL in each patient from the ligament of Treitz to ICV; it ranged from 440 to 1000 cm but cases with TSBL less than 600 cm are excluded, so only cases ranged from 600 to 1000 cm are included in this study. We did not find a significant correlation between TSBL and age, BMI, or sex. On the other hand, weight and height were positively correlated with TSBL.

Most surgeons do not routinely measure TSBL while performing bariatric surgery. Bariatric surgeons use standard distances for the small bowel configurations [7, 8]. In bariatric surgery, there is the risk of short bowel syndrome and malnutrition on one hand versus the risk of weight regain and the continuation of comorbidities on the other hand [9].

Table 6 Actual weight, actual body mass index, and the percentage of excess body weight loss of the two groups of patients at follow-up 3, 6, and 12 months after surgery

	Conventional group ($n = 30$)	Distal group ($n = 30$)	p value
Body weight (kg)			
Baseline	141.7 ± 23.9	142.3 ± 26.6	0.929
At 3 months	118.8 ± 19.9	120.0 ± 23.5	0.822
At 6 months	109.3 ± 17.2	106.6 ± 20.4	0.570
At 12 months	94.3 ± 12.1	91.7 ± 14.6	0.450
Body mass index (kg/m^2)			
Baseline	52.2 ± 9.7	54.9 ± 9.2	0.273
At 3 months	45.5 ± 8.7	44.6 ± 7.9	0.950
At 6 months	41.9 ± 7.4	39.6 ± 7.0	0.217
At 12 months	36.0 ± 4.8	34.1 ± 4.9	0.126
EBWL%			
At 3 months	31.9 ± 10.4	31.8 ± 11.5	0.986
At 6 months	44.5 ± 9.6	50.4 ± 16.0	0.088
At 12 months	63.1 ± 8.7	69.4 ± 15.4	0.056

Data presented as mean ± SD

Table 7 Correlation between the percentage of afferent loop length to total small bowel length and the percentage of excess body weight loss during follow-up after surgery

	Percentage of afferent loop length to total small bowel length	
	Correlation coefficient (*r*)	*p* value
%EBWL		
At 3 months	− 0.201	0.124
At 6 months	− 0.023	0.862
At 12 months	0.131	0.320

In the distal group, the mean afferent loop length was 301 ± 104 cm and the percentage of afferent loop length to TSBL was significantly larger compared with the conventional group. However, the end result was comparable effectiveness in the weight loss and resolution of comorbidities.

Many studies have assessed the influence of variation in the bypassed limb on weight loss. Previous studies indicated that the longer Roux limbs improve weight loss in super-obese but not in morbidly obese patients [10–13]. Lee et al. proposed that the bypassed limb for gastric bypass could be tailored according to the preoperative BMI of morbidly obese patients in patients undergoing OAGB. They found a satisfactory outcome in higher BMI patients. However, they advised careful application in lower BMI patients because of the nutritional problems [14]. Finally, a systematic review of small bowel limb lengths in RYGB found that bypassing more than 200 cm does not significantly improve weight loss in most patients [4].

Table 8 Follow-up of the laboratory tests 1 year after both techniques

	Conventional group (*n* = 30)	Distal group (*n* = 30)	*p* value
Hemoglobin (g/dL)	12.2 ± 1.3	10.5 ± 1.4	< 0.001
Serum iron (mcg/dL)	50.0 ± 17.1	38.9 ± 18.0	0.017
Serum calcium (mg/dL)	8.7 ± 0.4	8.6 ± 0.4	0.380
Parathormone hormone (ng/L)	50.1 ± 18.2	72.0 ± 16.7	< 0.001
Serum total proteins (g/dL)	6.8 ± 1.1	6.3 ± 0.8	0.036
Albumin (g /dL)	3.7 ± 0.7	3.3 ± 0.5	0.015
Blood urea (mg/dL)	24.5 ± 4.7	23.3 ± 6.3	0.397
Serum creatinine (mg/dL)	0.8 ± 0.1	0.7 ± 0.1	0.108
Fasting blood glucose (mg/dL)	85.2 ± 10.6	86.5 ± 9.0	0.610
Serum cholesterol (mg/dL)	174.4 ± 27.6	153.2 ± 45.6	0.035
Serum triglycerides (mg/dL)	100.2 ± 17.2	86.5 ± 16.7	0.003
SGPT (U/L)	24.1 ± 10.3	27.2 ± 14.0	0.333
SGOT (U/L)	24.6 ± 8.4	38.2 ± 12.1	< 0.001

Data are presented as mean ± SD

Table 9 The frequency of nutritional deficiencies in both groups before surgery and 12 months after surgery

	Conventional group (*n* = 30)	Distal group (*n* = 30)	*p* value
Hemoglobin deficiency			
Before surgery	3 (10.0%)	6 (20.0%)	0.254
12 months after surgery	8 (26.7%)	20 (66.7%)	0.002
Iron deficiency			
Before surgery	3 (10.0%)	7 (23.3%)	0.145
12 months after surgery	7 (23.3%)	23 (76.7%)	< 0.001
Calcium deficiency			
Before surgery	0 (0%)	0 (0%)	
12 months after surgery	2 (6.7%)	2 (6.7%)	1.000
Hypoalbuminemia			
Before surgery	0 (0%)	0 (0%)	
12 months after surgery	2 (6.7%)	11 (36.7%)	0.005

All the previous studies did not consider the TSBL. Therefore, in the current study, we speculated whether there is an ideal percentage of bypassed limb length in relation to TSBL that might achieve greater long-term weight loss without increasing the number of nutritional complications.

Savassi-Rocha et al. published the first study of the influence of TSBL and CL length on weight loss. They reported a negative correlation between CL length and weight loss in males and in super-obese patients after a 12-month follow-up [15]. Subsequently, in a retrospective study of 120 RYGB, Sarhan et al. emphasized the importance of the measurement of TSBL and CL length when analyzing the results of surgery [16]. A prospective study of 151 patients undergoing laparoscopic RYGB studied the influence of the CL length on the outcome. They measured the small intestine length using microforceps. They found that the percentage of CL

Table 10 The frequency of complete resolution of obesity-related comorbidities at 12 months after surgery in the two studied groups

	Conventional group (*n* = 30)	Distal group (*n* = 30)	*p* value
Type 2 diabetes mellitus	9/14 (64.3%)	10/16 (62.5%)	0.781
Hypertension	4/10 (40%)	6/9 (66.7%)	0.488
Hyperlipidemia	19/23 (82.6%)	18/21 (85.7%)	0.791
Bronchial asthma	1/1 (100.0%)	2/3 (66.7%)	1.000
Osteoarthritis	7/13 (53.8%)	10/19 (52.6%)	0.390

Table 11 The gastrointestinal quality of life index (GIQLI) score at follow-up 3, 6, and 12 months after surgery in the two groups

	Conventional group ($n = 30$)	Distal group ($n = 30$)	p value
GIQLI at 3 months	96.3 ± 8.3	89.1 ± 12.9	0.013
GIQLI at 6 months	104.3 ± 12.4	95.4 ± 12.0	0.006
GIQLI at 12 months	105.9 ± 11.2	97.6 ± 10.2	0.004

GIQLI gastrointestinal quality of life index

length had no influence on the %EWL in obese and super-obese patients [8].

The one-anastomosis gastric bypass is rapidly gaining acceptance and is now an established bariatric procedure [17]. In the current study, the two surgical techniques were safe with no significant early or late postoperative complications. There were no complications related to bowel handling during the process of bowel measurement. The distal technique had two drawbacks: more patients with nutritional deficiencies and lower gastrointestinal quality of life index (GIQLI) score. The two problems were correlated with a higher percentage of afferent loop length to TSBL.

A point of strength of this study, in addition to patient safety and effectiveness of both procedures, is that it was well randomized with two comparable groups regarding demographic and clinical characteristics, and total small bowel length. However, the small sample size of the study and the short follow-up period are the main limitations. Therefore, before any firm conclusions are drawn, larger sample size and longer follow-up period are required for better judgment of the distal technique of OAGB and its potential role in improving outcomes.

In conclusion, OAGB can achieve satisfactory results when the afferent loop length is 200 cm. Bypassing more than 200 cm of the small bowel does not improve weight loss or resolve comorbidities significantly, and it is associated with more frequent nutritional deficiencies and lower gastrointestinal quality of life index (GIQLI) score. To guard against excessive shortening of the small bowel that might increase the risk of nutritional consequences, measuring the total small bowel length (TSBL) is recommended. Long-term result in this small cohort is needed.

Table 12 Correlation between the percentage of afferent loop length to total small bowel length and the gastrointestinal quality of life index score in all studied patients at follow-up 3, 6, and 12 months after surgery

	Percentage of afferent loop length to total small bowel length	
	Correlation coefficient (r)	p value
GIQLI		
At 3 months	− 0.724	< 0.001
At 6 months	− 0.673	< 0.001
At 12 months	− 0.598	< 0.001

GIQLI gastrointestinal quality of life index

Compliance with Ethical Standards This randomized control trial (RCT) was conducted in two university hospitals between April 2016 and December 2018 after obtaining approval from the institutional review boards and ethical committees of the two hospitals. After explaining the study procedure, the techniques, the possible side effects, and outcome which may be favorable, an informed consent was obtained from each participant before surgery.

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

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