



## THE IMPACT OF ADDING BRAUN ANASTOMOSIS TO ONE-ANASTOMOSIS GASTRIC BYPASS ON POSTOPERATIVE GASTROESOPHAGEAL REFLUX DISEASE

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### ABSTRACT

**Background:** Bariatric surgery has been established as the only successful treatment option for morbid obesity and its related comorbidities. The one-anastomosis gastric bypass (OAGB) has currently evolved as a new surgical option for the treatment of obesity that has gained rapid popularity worldwide. Nevertheless, several concerns have been raised concerning its related complications and the need for revision. **Aim of the study:** This work aimed to compare routine OAGB and OAGB with added enteroenterostomy in the patients' short-term outcomes including the incidence of gastroesophageal reflux disease (GERD). **Patients and methods:** This is a randomized controlled study that was conducted on consecutive patients scheduled for OAGB. Patients were randomly allocated to one of two groups; group 1 included patients who underwent LOAGB with added Braun enteroenterostomy, and group 2 included patients who underwent the standard LOAGB. **Results:** Eighty patients were in the study population; 41 were in group 1, and 39 were in group 2. At 6-months postoperatively, both groups showed significant weight loss ( $p < 0.001$  for both). A statistically significant higher %TWL was shown in group 1 ( $29.68 \pm 4.45$  vs.  $27.86 \pm 0.79$ ,  $p = 0.012$ ). Less incidence of gastroesophageal inflammation and bile reflux was shown in the group with added Braun anastomosis. However, with no statistical significance. The scores of the GSFQ ranged from 3 to 25, with statistically significantly higher median values in group 2 (11 vs. 8,  $p = 0.037$ ). **Conclusion:** Adding Braun anastomoses to LOAGB resulted in less postoperative GERD and a better patient outcome. Further multi-center studies on large samples with long-term follow-up will help in adopting standardization of the initial adding Braun anastomosis to LOAGB.

**Keywords:** laparoscopic one anastomosis gastric bypass (LOAGB), bile reflux, Braun anastomosis.

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### INTRODUCTION

The current rise of obesity prevalence worldwide, with its associated negative impact on human health, has had to correspond with an upward trend in the development of various therapeutic options for this health disorder [1]. Bariatric surgery has been established as the only successful treatment option for morbid obesity ( $BMI > 40$  kg/m<sup>2</sup>), together with its associated comorbid conditions [2].

Laparoscopic Roux-en-Y gastric bypass (LRYGB) and laparoscopic sleeve gastrectomy (LSG) are the most frequently practiced bariatric surgeries [3]. However, the one-anastomosis gastric bypass (OAGB) has currently evolved as a new surgical option for the treatment of obesity that has gained rapid popularity worldwide. One-anastomosis gastric

bypass encompasses the creation of a narrow long gastric pouch, which is anastomosed to the small intestine about 2 m cm distal to the Treitz angle. OAGB includes afferent and efferent loops rather than an alimentary limb, bypassing the whole duodenum and the first 200 cm of the small intestine [1].

Since its emergence, and being a restrictive and malabsorptive procedure, OAGB has shown efficacy and safety in the treatment of obesity and its associated comorbidities [4-7]. Nevertheless, several concerns have been raised concerning its related complications, such as malnutrition, bile reflux, and gastroesophageal malignancy [8-11].

Braun anastomosis, which is a lateral enteroenterostomy located distal to the gastrojejunal

anastomosis has been described in pancreatic and gastric resection surgery to divert bile passage away from the remaining portion of the stomach [12]. It has shown efficiency in the prevention of bile reflux and delayed gastric emptying [12]. Braun anastomosis is a simpler solution for refractory bile reflux that may follow OAGB than revision to RYGB [13]. However, there is still scarce evidence regarding its effectiveness in the context of OAGB. This work aimed to compare routine OAGB and OAGB with added enteroenterostomy in the patients' short-term outcomes.

#### PATIENTS AND METHODS

This is a randomized controlled study that was conducted in the surgery department of our institution, between June 2019 and February 2021. The study was conducted after approval by the institutional review board and per the Helsinki declaration.

Adult patients with a BMI of  $\geq 40$  kg/m<sup>2</sup> or  $\geq 35$  kg/m<sup>2</sup> with comorbidities were candidates for bariatric surgery at our institution if they had failed conservative management for at least six months, and were fit for surgery under general anesthesia. Patients who had type 2 diabetes mellitus or who frequently indulged in sweets were initially chosen for OAGB. The final decision about the surgery type was taken according to the patient's preference after presenting the appropriate alternatives. Consecutive patients scheduled for OAGB who accepted to join the study and complied with the follow-up evaluation were eligible for the study.

All patients were subjected to the standard preoperative work-up including proper history taking, clinical assessment, routine preoperative laboratory investigations, abdominal sonography, and upper gastrointestinal (GIT) endoscopy. Patients with abnormal upper GIT endoscopy were excluded. Patients who were active alcohol abusers within 2 years before the screening visit, patients with a

history of toxic drug and/or steroid supplements within 30 days before the study, and those with previous upper GIT surgery, congenital, inflammatory, or hemorrhagic diseases of the GIT, pancreatitis, esophageal dysmotility, GERD, hiatal hernia, advanced systemic disease, immunodeficiency or autoimmune connective tissue disorders, and significant mental or neurological diseases were also excluded. Written informed consent was obtained from each patient before their enrollment in the study.

#### Randomization

The study patients were randomly allocated to one of two groups; group 1 included patients who underwent LOAGB with added Braun enteroenterostomy, and group 2 included patients who underwent the standard LOAGB. A simple randomization technique using computer-generated random numbers by Microsoft Excel was performed by an independent hospital employer utilized for patients' randomization.

#### Operative procedure

Thromboembolic prophylaxis was secured with preoperative subcutaneous low-molecular-weight heparin on the evening prior to surgery. The surgery was conducted under general anesthesia. The patient was set in the supine position, with the surgeon positioned between the patient's legs (French position). Compressive stocks were applied to the patient's lower legs. Pneumoperitoneum was created as usual keeping an intra-abdominal pressure of 12-15 mmHg. After the creation of the pneumoperitoneum, five trocars were introduced in the upper abdomen in a diamond-shaped distribution. The laparoscopic procedure had two components; first, a restrictive component that involved the creation of a narrow gastric pouch (Figure 1), and second, a malabsorptive component that involved performing a 200-cm or-longer jejunal bypass via the creation of an anterior, antecolic loop gastrojejunostomy (GJ) (Figure 2).

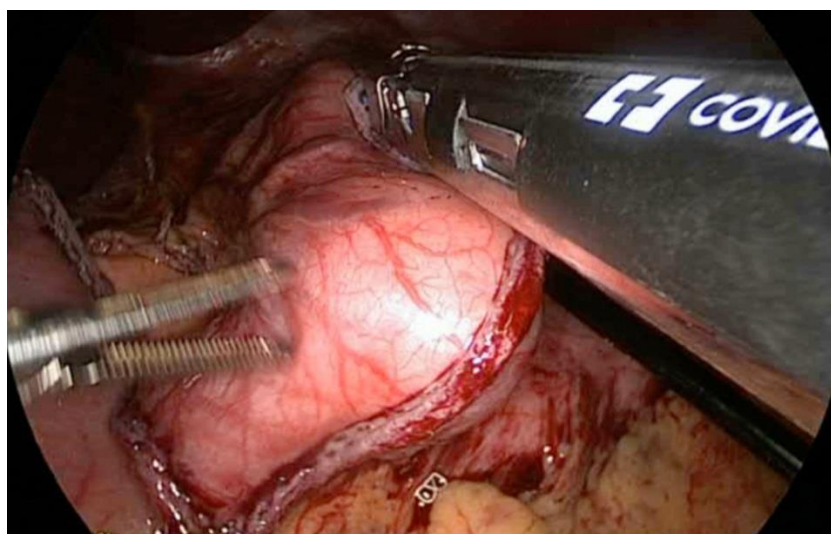
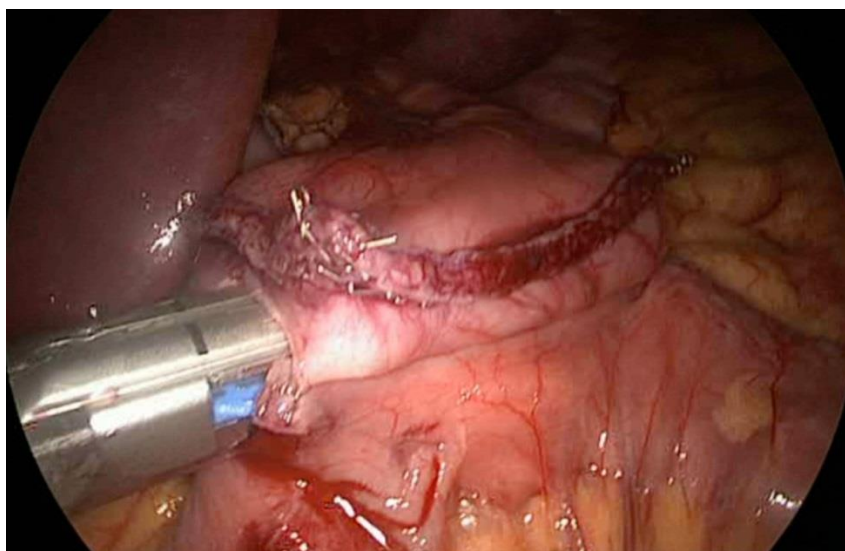
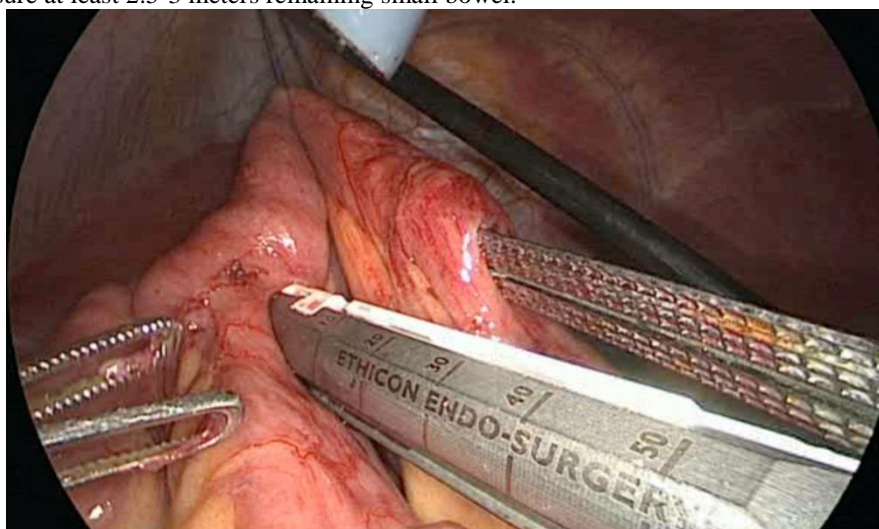


Figure 1: Creation of the gastric pouch in one of the study patients



**Figure 2:** Creation of the loop gastrojejunostomy using an Endo-GIA linear stapler in one of the study patients. In group 1, Braun enteroenterostomy was performed. Both the afferent and efferent jejunal limbs were run to ~50 cm from the gastrojejunal anastomosis. A stay suture was taken to hold the 2 loops together. Enterotomies were made in both jejunal limbs at the same level, just distal to the stay suture (Figure 3). A 30-mm Endo-GIA linear stapler was then used to create a side-to-side anastomosis between the 2 limbs (i.e. a side-to-side Braun enteroenterostomy). The enterotomy openings were closed using absorbable monofilament suture Stratafix (Ethicon Endosurgery, Inc., Cincinnati, OH, USA) in a hand-sewn technique. The distal common channel was checked to ensure at least 2.5-3 meters remaining small bowel.



**Figure 3:** Using an Endo-GIA linear stapler to create a Braun enteroenterostomy (Braun anastomosis) in one of group (1) patients.

Patients were encouraged to early mobilization following surgery. They commenced a liquid diet on postoperative day 1. Patients were discharged home once they were hemodynamically stable, had no complications, had audible bowel sounds, were well tolerated on a liquid diet and had pain control with oral analgesia. Upon discharge, thromboembolic prophylaxis was continued once daily postoperatively for 2 weeks. Patients received instructions concerning postoperative fluid intake, diet, and follow-up schedules (1 week, 1 month, and 6 months postoperatively).

The percentage of total weight loss (%TWL) was measured in all patients 6 months after surgery as % TWL= BMI loss/baseline BMI  $\times$ 100% [14].

To assess gastroesophageal reflux disease (GERD) symptoms, and their effect on the patient's physical and psychological well-being, all the study patients were asked to complete the GERD Symptom Frequency Questionnaire (GSFQ) 6 months after surgery. The GSFQ is a simple, short, self-administered questionnaire. It consists of six questions. The answers to the first four questions are scored from 4 to 0, with the higher score denoting experiencing the asked symptom more frequently. After that, two questions assessing the number of



days during which symptoms have interfered with daily life activities, and sleep, respectively. According to the number of days in the prior week, the answers are scored from 0 to 7. Finally, the GSFQ score ranges from 0 to 30. This final score is then divided by 0.3 to get the overall GSFQ score, which ranges from 0 to 100 [15].

At 6 months postoperatively, an upper GI endoscopy was performed for all patients to assess for evidence of bile reflux and any esophageal or gastric mucosal changes. Bile reflux was diagnosed when the upper GIT endoscopy demonstrated bile in the esophagus or a considerable amount of bile in the gastric pouch.

**Study outcomes**

The primary outcome of our study was the difference between both groups in the occurrence of bile reflux and gastroesophageal inflammatory changes. The secondary outcomes were the differences in the operative time, intra-operative and post-operative adverse events, %TWL, and the rates of comorbidities remission.

**Statistical analysis**

The patients' data were analyzed using the SPSS statistical software (IBM Corp., Armonk, NY, USA), version 28. Categorical values were presented as frequencies and percentages and compared using the Chi-square test, Fisher's exact test, McNemar test, or z-test for proportion as appropriate. Numerical values were expressed according to normality testing, and a t-test (paired or independent) or Mann-Whitney test was performed accordingly. A p-value less than 0.05 was considered statistically significant.

**RESULTS**

This prospective randomized study included 84 patients scheduled for LOAGB who were equally allocated to undergo LOAGB with added Braun enteroenterostomy (n=42) or standard LOAGB (n=42). One patient in group 1 and three patients in group 2 did not complete the study and dropped out during follow-up. Finally, 80 patients were the study population; 41 were in group 1, and 39 were in group 2 (Figure 4).

CONSORT 2010 Flow Diagram

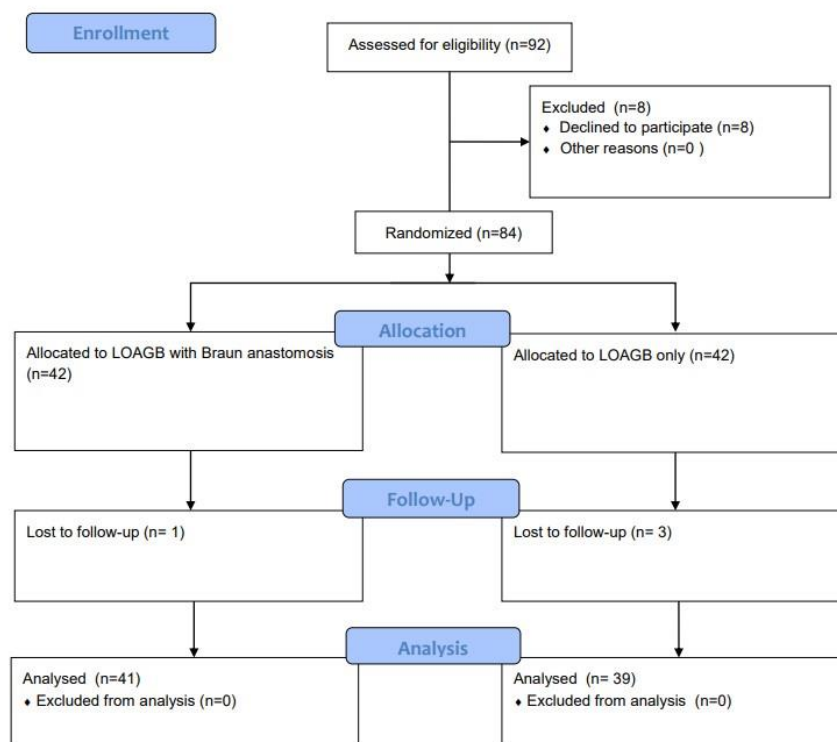


Figure 4: CONSORT flow diagram of the study patients

The patients' ages ranged from 18 to 54 years, with a mean of 37.9 ± 9.4. Females were slightly predominant constituting 57.5% of the study patients (46 cases). The baseline BMI ranged from 41.25 to 47.32 kg/m<sup>2</sup>, with a mean of 44.5±1.8 kg/m<sup>2</sup>. The patient's comorbidities were mainly dyslipidemia

(50%), diabetes mellitus (23.8%), and hypertension (18.8%). Both groups had comparable baseline data (Table 1). The mean operative time was longer in group 1 (3.92 ± 0.42 hours) than in group 2 (3.78 ± 0.39). However, without statistical significance (p= 0.18). No major intra-operative complications were

reported in any of the study patients (Table 1). At the 6-month postoperatively, both groups showed significant weight loss ( $p < 0.001$  for both). A statistically significant higher %TWL was shown in group 1 ( $29.68 \pm 4.45$  vs.  $27.86 \pm 0.79$ ,  $p = 0.012$ ) (Table 1). Concerning patients' comorbidities, remission was evident, with a statistically significant

remission of dyslipidemia ( $p < 0.001$  in group 1 and  $p = 0.008$  in group 2) and remission of hypertension and diabetes mellitus that was statistically non-significant in both groups. Both groups were comparable in the 6-month follow-up prevalence of comorbidities (Table 1).

**Table 1:** The clinical data of the study patients

		Group 1 (n=41)	Group 2 (n=39)	P
		Mean $\pm$ SD, Median (range)	Mean $\pm$ SD Median (range)	
Age (years)		37.54 $\pm$ 8.95, 37 (18-54)	38.31 $\pm$ 9.95, 38 (21-54)	0.72 <sup>a</sup>
BMI (kg/m <sup>2</sup> )	Preoperative	44.55 $\pm$ 1.82, 44.48 (41.27-46.99)	44.45 $\pm$ 1.83, 44.45 (41.25-47.32)	0.81 <sup>a</sup>
	6-months postoperative	31.33 $\pm$ 2.38, 31.76 (24.5-34.02)	32.07 $\pm$ 1.39, 31.97 (29.7-34.65)	0.098 <sup>a</sup>
	<b>p<sup>b</sup></b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	
Operative time (hours)		3.92 $\pm$ 0.42, 4 (3-4.55)	3.78 $\pm$ 0.39, 3.75 (3.1-4.5)	0.18 <sup>a</sup>
%TWL		29.68 $\pm$ 4.45, 28 (25.57-41.74)	27.86 $\pm$ 0.79, 27.79 (26.5-29.16)	0.012 <sup>a</sup>
		N (%)	N (%)	
Sex	Female	24 (58.5)	22 (56.4)	0.85 <sup>c</sup>
	Male	17 (41.5)	17 (43.6)	
<b>Comorbidities</b>				
Preoperative dyslipidemia		23 (56.1)	17 (34.59)	0.26 <sup>d</sup>
6-months dyslipidemia		12 (29.27)	9 (23.08)	0.53 <sup>d</sup>
<b>p<sup>e</sup></b>		<b>&lt;0.001</b>	<b>0.008</b>	
Preoperative DM		8 (19.5)	11 (28.2)	0.36 <sup>d</sup>
6-months DM		4 (9.76)	7 (17.95)	0.29 <sup>d</sup>
<b>p<sup>e</sup></b>		<b>0.13</b>	<b>0.13</b>	
Preoperative HTN		7 (17.07)	8 (20.51)	0.69 <sup>a</sup>
6-months HTN		3 (7.32)	5 (12.82)	0.41 <sup>a</sup>
<b>p<sup>e</sup></b>		<b>0.13</b>	<b>0.25</b>	

a: independent t test, b: paired t test, c:  $\chi^2$ : Chi square test, d: Z, Z score for proportion, e: Mc-Nemar test

Group 1 showed less incidence of mucosal inflammation (4.9% vs. 12.8%), and bile reflux (9.8% vs. 23.1%), as demonstrated by upper GIT endoscopy. However, without statistical significance ( $p = 0.209$  and  $0.106$ , respectively (Table 2). The original scores of the GSFQ ranged from 3 to 25, with statistically significantly higher median values in group 2 (11 vs. 8,  $p = 0.037$ ). After the division of the scores by 0.3, the scores ranged from 10 to 83.33, with significantly higher mean values in group 2 ( $37.09 \pm 18.45$  vs.  $29.02 \pm 16.65$ ,  $p = 0.043$ ) (Table 2).

Postoperative complications were encountered in 3 patients. One patient (in Group 1) had reflux

esophagitis and esophageal dysplasia. Upper GIT endoscopy revealed inflamed esophageal mucosa, and the biopsy showed early esophageal hyperkeratosis with mild dysplasia. After control of the acute inflammatory process, this patient was subjected to mucosal resection with an uneventful post-procedure recovery. Another patient (in group 2) had severe bile reflux gastritis, confirmed by upper GIT endoscopy, and was treated with a combination of Sucralfate and a PPI. Deep venous thrombosis (DVT) occurred in one patient (in group 2) on POD15. The patient was successfully treated by conservative management including therapeutic anticoagulation.

**Table 2:** The GERD related data of the study patients

	Group 1 (n=41)	Group 2 (n=39)	p
	Mean ± SD, Median (range)	Mean ± SD Median (range)	
<b>GSFQ score</b>	8.7 ± 5, 8 (3-24)	11.13 ± 5.54, 11 (4-25)	0.037 <sup>f</sup>
<b>GSFQ score/0.3</b>	37.09 ± 18.45, 26.67 (10-80)	29.02 ± 16.65, 36.67 (13.33-83.33)	0.037 <sup>f</sup>
	N (%)	N (%)	
<b>Upper GIT mucosal abnormalities</b>	2 (4.9)	5 (12.8)	0.209 <sup>c</sup>
<b>Bile reflux</b>	4 (9.8)	9 (23.1)	0.106 <sup>c</sup>

c: X<sup>2</sup>: Chi square test, f: Mann Whitney test.

## DISCUSSION

The OAGB's advocates contend that its effectiveness is comparable with that of RYGB, the gold standard in bariatric surgery, although it is an easier surgery with simpler revision or reversion if necessary [16]. Despite the ongoing wide acceptance of LOAGB, concerns are still raised about its predisposition to bile reflux, which may be intractable enough to require revisional surgery, and its associated persistent mucosal irritation, which is a risk factor for esophageal and gastric cancer [17].

Surgical revision-of post-OAGB refractory bile reflux could be conversion to RYGB [17], or the simpler option of Braun anastomosis, which involves the creation of side-to-side jejunojejunostomy between the OAGB afferent and efferent limbs [18,19].

Our study demonstrated an overall better outcome of LOAGB with added Braun anastomosis compared to the standard LOAGB in terms of weight loss and the scores of GSFQ, which reflects the patient's clinical state and quality of life since the weight of total score was based mainly on the last two questions because they reflect particularly the quality of life [15]. Fewer incidences of gastroesophageal inflammatory changes and bile reflux was also shown. However, without statistical significance. This is likely due to the relatively small sample size. These benefits of adding Braun anastomoses were not at the expense of the operative feasibility, since no intraoperative adverse events occurred in either of the two groups, and the difference in the mean operative time was neither statistically nor clinically significant. Regarding safety, a few complications were encountered with no significant difference between both groups.

The Braun anastomosis efficacy in the diversion of bile after resectional surgery of the stomach is well documented [20]. However scarce evidence is available about its role in bariatric practice. Almerie et al. [13], in a letter to the editor, declared that Braun anastomosis was effective for the treatment of bile reflux after OAGB with high efficacy. Only one study could be reached comparing patients who underwent LOAGB with those who underwent LOAGB with Braun anastomosis as a primary

procedure [21]. In congruence with this study, the authors found that Braun anastomosis showed usefulness in the prevention of *de novo* bile reflux and esophagitis [21]. This was a retrospective analysis of a hospital database. Our study is the first to compare these two cohorts in a randomized controlled design, which is the highest level of evidence in research. We believe that the lack of statistical significance in the reduction of reflux incidence and mucosal inflammatory changes is attributed to the relatively small sample size. This is ensured by the significantly lower GSFQ scores and highlights an overall better patient condition.

A side advantage for Braun anastomosis was shown in terms of a significantly higher rate of weight loss. There was no previously proposed consensus for such a finding. A plausible examination may be the less prevalent GERD-related sleep disturbance that was shown in the group with added Braun anastomosis, as driven by the GSFQ analysis. Sleep disturbance has been established to be associated with decreased metabolic rate and increased food consumption, with a net result of weight gain [22].

This study adds new evidence for the efficacy and safety of Braun anastomosis and its applicability in the bariatric practice being added to LOAGB as a primary procedure. The study is limited by the relatively small sample size and being a single-center study.

## CONCLUSION

Adding Braun anastomoses to LOAGB resulted in less postoperative GERD and a better patient outcome. Further multi-center studies on a large sample with long-term follow-up are will help in adopting standardization of the initial adding Braun anastomosis to LOAGB.

**Statement for conflict of interest:** The authors declare no conflict of interest.

**Ethical approval:** This study has been approved by the appropriate institutional research ethics committee.

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