Comparative study between antral resection and antral preservation during laparoscopic sleeve gastrectomy for morbid obese patients: a prospective randomized clinical controlled trial

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Purpose
The aim of this study was to compare between antral resection (gastrectomy begins 2 cm from pylorus) and antral preservation (gastrectomy begins 6 cm from pylorus) during laparoscopic sleeve gastrectomy regarding the weight loss, postoperative complications, and nutritional and elemental deficiencies.
Patients and methods
This was a randomized controlled trial, in which 40 adult obese patients (assigned to undergo laparoscopic sleeve gastrectomy) were randomly allocated into two groups: one group was assigned to antral resection (gastrectomy begins 2 cm from pylorus), whereas the other group was assigned to antral preservation (gastrectomy begins 6 cm from pylorus). Weight and BMI of the participants was measured during follow-up at 3, 6, and 12 months to compare the weight loss between the two groups. Other outcomes that were compared between the two groups included resolution of comorbidities, gastric emptying, short-term postoperative complications, and nutritional deficiencies (iron, vitamin b12, and calcium).
Results
There were no significant differences between the antral resection and antral preservation groups regarding postoperative complications (both short term and long term), resolution of comorbidities, or weight loss. The only significant difference was in the postoperative gastric emptying time, which was significantly delayed in the antral resection group (P=0.02).
Conclusions
The surgical approach regarding the size of the antrum does not affect the safety and postoperative complications, but it is still not clear whether or not there is a difference regarding the weight loss. Our study suggests that there is no significant difference in the weight loss after surgery during the first year of follow-up. The significant difference in postoperative gastric emptying shows the importance of the pyloric antrum in the normal physiology of the stomach.

Keywords:
antral preservation, antral resection, sleeve gastrectomy

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Introduction

Laparoscopic sleeve gastrectomy (LSG) has been one of the most popular techniques in the field of obesity and bariatric surgery, with a significant increase in its popularity between surgeons during the past 20–25 years [1]. Throughout the last decade, further studies were performed to assess the benefits and risks of the LSG. Several studies found that the effects of LSG on weight loss, resolution of comorbidities, and improvement of quality of life were highly significant and comparable to other bariatric surgeries [2–7]. Several studies supported the safety of LSG regarding postoperative complications with the exception of staple line leakage and bleeding, but other short-term postoperative complications were very rare to occur [8–11]. On the contrary, several long-term postoperative complications have been reported such as gastroesophageal reflux disease (GERD), nutritional anemias (whether iron deficiency or vitamin b12 deficiency), and also poor weight loss and weight regain [12].

Given the fact that there are a lot of issues to be addressed when it comes to LSG, a lot of surgeons have been trying to find modifications that can be done during preoperative, intraoperative, or postoperative stages of the process [12].

One of the steps of the LSG procedure that has been under a lot of debate in the last decade is the starting

point of gastrectomy in relation to the pylorus of the stomach, as the distance from pylorus will decide the size of the antrum post gastrectomy. There are two techniques: the first is antral preservation technique where the operator starts gastrectomy (4–6 cm) away from the pylorus to preserve a large part of the antrum, and the second is antral resection technique where the operator starts gastrectomy (2–3 cm) away from the pylorus to resect most of the pylorus [13].

The difference between the two techniques regarding postoperative outcomes generally and specifically related to weight loss, reflux, and gastric emptying is an ongoing question that needs more randomized trials for further clarity and guideline implementation [14].

This was the main focus of this study as we tried to compare between the two techniques and report what significant differences might be present between the two techniques in question.

Patients and methods

Patients

This was a prospective randomized study that was conducted in Ain Shams University Hospitals Bariatric Surgery Unit. It included 40 morbid obese patients. Patients were divided into two groups: group A was composed of 20 patients assigned to antral resection sleeve gastrectomy (gastrectomy 2 cm from pylorus), and group B was composed of 20 patients assigned to antral preservation sleeve gastrectomy (gastrectomy 6 cm from pylorus).

Inclusion criteria

The following were the inclusion criteria:

(1) Patients fit for surgery.
(2) Adult male or female patients, aged 18–60 years.
(3) Patients who have BMI=40 or more/BMI=35 or more with comorbidities.
(4) Bulk eater patients.

Exclusion criteria

The following were the exclusion criteria:

(1) Patients with previous bariatric surgery.
(2) Sweet eaters.
(3) Patient refusal.
(4) Drugs and alcohol abusers.
(5) Patients with hiatal hernia.

Randomization

The randomization was done through random allocation using computer software-based randomization. The patients were randomized into two groups: in group A, gastrectomy started 2 cm from the pylorus, and in group B, gastrectomy started 6 cm from the pylorus. Informed consent was obtained from all patients to be included in the study, after explaining the operative and postoperative details and complications. The study was approved by the local ethical committee of the hospital.

Operative technique

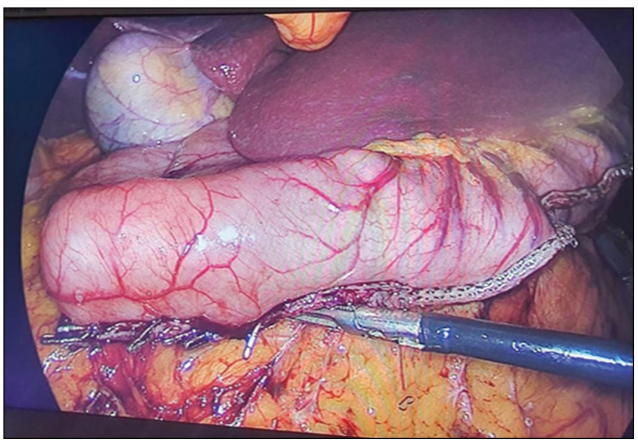
The operation was done under general anesthesia. Patient was in supine position. The procedure was started using a 12-mm optical trocar to enter the abdomen under direct vision about 20 cm below the xiphoid process and 2 cm to the left side of the midline. Pneumoperitoneum was achieved with carbon dioxide to 15 mmHg. Four additional ports were placed under direct vision.

The operating table was changed to steep reverse Trendelenburg position. Dissection was started with opening of the greater omentum 2 or 6 cm proximal to the pylorus using 5 Ligasure. The dissection was then continued toward the gastroesophageal junction.

The left crus was then completely free of any attachments to avoid leaving a posterior pouch when constructing the sleeve in this region. Posterior attachments between the stomach and pancreas were divided.

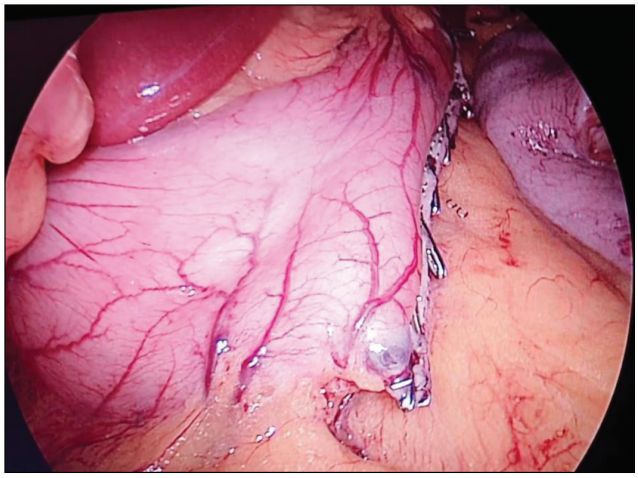
After insertion of a 36 French gastric calibration tube, gastric transection was started 2 cm proximal to the pylorus using a 60-mm green endo-stapler (group A) (Fig. 1) or 6 cm from the pylorus (group B) (Fig. 2). The following staplers were then placed ~1 cm from the bougie in the direction of the gastroesophageal junction. The remaining staplers were 60-mm blue cartridges. After the transection was completed, bleeding points were secured using 10-mm endoclips or vicryl 2/0 intracorporeal

Figure 1



Sleeve gastrectomy with antral resection.

Figure 2



Sleeve gastrectomy with antral preservation.

suture. The transected stomach was then removed through the 12-mm right midclavicular port. Methylene blue was injected into the stomach, and the staple line was inspected carefully for leak. The methylene blue was then removed from the stomach. Abdominal drain was inserted and removed on the second postoperative day after the patient started oral fluids.

Follow up

Follow-up was performed at 2 weeks, 3 months, 6 months, and 1 year postoperatively. Patients were also seen at the outpatient clinic if they developed symptoms between their follow-up visits.

Assessments

The primary outcome was the weight loss, which was assessed as the percentage of excess weight loss (%EWL) of patients of each group. Excess weight before surgery was calculated as the weight in kg more than that equivalent to BMI 25 kg/m^2. The %EWL was calculated by using the following formula: 100×(weight before surgery–weight at each follow-up visit)/excess weight. The secondary outcomes included operative time; gastric emptying; hospital mortality; nutritional status, including vitamin b12/calcium/anemia; improvement of comorbidity; and postoperative complications, including bleeding, leakage, vomiting, and pulmonary complications.

Data collected

Preoperative data included age, sex, weight, height, BMI, obesity comorbidities affecting each patient (diabetes mellitus, hypertension, dyslipidemia), and preoperative gastric half emptying (GE.t1/2). Gastric half emptying was assessed using scintigraphy, which uses gamma cameras to create two-dimensional images, which is generally regarded as the gold standard for gastric emptying. Having fasted for around four hours before the scan, the patient was given a semi-solid meal (scrambled eggs on toast), which has been prepared with a radiopharmaceutical component technetium-99m sulfur colloid.

Intraoperative data included mainly the operative time of the procedure in both arms of the study.

Postoperative data included short-term postoperative complications (bleeding, vomiting, respiratory tract infection, and postoperative in-hospital mortality); delayed postoperative complications (GERD, vitamin B12 deficiency, hypocalcemia defined as serum calcium <8.5 mg/dl, and anemia defined as hemoglobin concentration <13 g/dl for males and 11 g/dl for females); resolution of obesity-related comorbidities defined as either complete (cessation of medication prescription for the related comorbidity) or partial (decreasing the number and dosage of the prescribed medication for the related comorbidity); BMI and weight of the patients at 3, 6, and 12 months during the follow-up; and gastric half emptying (GE.t1/2), which was assessed 3 months after the operation.

Statistical analysis

Statistical analysis was done using IBM SPSS statistics for windows, Version 23.0 (Armonk, NY: IBM Corp.). Categorical variables were reported using percentages and frequency tables. Continuous variables were reported using descriptive statistics described as mean±SD. χ^2 test and Fisher exact test were used for hypothesis testing of categorical outcomes. Student's t test was used for hypothesis testing of continuous outcomes. P values less than 0.05 was considered to be significant, less than 0.01 was considered highly significant, and more than 0.05 was considered insignificant. Significance was two tailed.

Results

Preoperative characteristics

The sex of the patients included in the sample of the study were 62.5% (25) females and 37.5% (15) males, with the percentage within each group also comparable: group A (resection group) had 65% (13) females and 35% (seven) males, whereas group B (preservation group) had 60% (12) females and 40% (eight) males. The mean age of the patients of the sample was 38.3 (SD=11 years). The mean BMI of the patients was 39.8 kg/m^2 (SD=5 kg/m^2). The frequency of comorbidities in the patients was 65%, with the diabetes mellitus being the most common obesity comorbidity (35%). The mean preoperative gastric emptying t1/2 using scintigraphy was 56.63 min (SD=13.1 min). All of the preoperative characteristics were comparable between the two arms of the study

Table 1 Mean±SD for age, BMI, operative time, and G.Et1/2

	Total (*N*=40)	Antral resection (A) (*N*=20)	Antral preservation (B) (*N*=20)
Sex: male [*n* (%)]	15 (37.5)	7 (35)	8 (40)
Female [*n* (%)]	25 (62.5)	13 (65)	12 (60)
Age (years)	38.3 ± 11	37 ± 10	39 ± 12
BMI (kg/m^2)	39.8 ± 5	40 ± 5	39.5 ± 4.5
Hypertension [*n* (%)]	7 (17.5)	3 (15)	4 (20)
Diabetes mellitus [*n* (%)]	14 (35)	7 (35)	7 (35)
Dyslipidemia [*n* (%)]	5 (12.5)	3 (15)	2 (10)
Operation time (min)	51 ± 8	51.2 ± 9	51.4 ± 7
Preoperative G.E (min)(t1/2)	56.3 ± 13.1	54 ± 11.2	58 ± 14.5

with no significant statistical difference found between either the categorical or the numerical variables and shown in Table 1.

Demographic characteristics.

Intraoperative data

The main intraoperative data collected and analyzed were the operative time. The mean duration of operation for all cases was 51.5 min (SD=8 min). The mean operative time for group A patients was 51.2 ± 9 min, whereas for group B was 51.4 ± 7 min, with no significant difference between the two groups (P>0.05).

Postoperative complications

The frequency of short-term postoperative complications (vomiting, bleeding, and respiratory tract infection) among all patients was 27.5% with vomiting being the most common as it occurred in five patients. As for the frequency within each group, it was comparable but slightly higher in group A with 15% for both vomiting and bleeding versus 10 and 5%, respectively, for group B. Respiratory tract infection was seen in 5% in both groups, with no statistically significant difference between the groups regarding any of the complications (P>0.05).

The frequency of delayed complications among all patients was GERD in 17.5%, iron-deficiency anemia in 15%, hypocalcemia in 7.5% and vitamin B12 deficiency in 10%. As for the frequency within each group, the numbers were comparable but slightly higher for group A as the frequency of GERD, anemia, hypocalcemia, and B12 deficiency within group A was 25%, 20, 10, and 15%, respectively, whereas within group B, the frequency was 10, 10, 5, and 5%, respectively, as shown in Table 2, with no statistically significant difference between the two groups regarding any of the complications (P>0.05).

Weight loss

Weight and BMI of the patients were measured at 3, 6, and 12 months. %EWL was computed at 3, 6, and 12 months to assess the weight loss in patients of each group. The mean %EWL was higher in the antral preservation group at all three measurements at 3, 6, and 12 months. %EWL was 41.8, 71.6, and 95% at 3, 6, and 12 months for group A, whereas it was 51, 78.4, and 103.2% at 3, 6, and 12 months for group B. However, there was no significant difference between the two groups in any of the follow-up measurements (P>0.05). Tables 3 and 4 show the difference between the groups in both BMI and %EWL.

Comorbidity

Resolution of comorbidities after surgery was very high with total frequency of 88.5% in both groups, with 92.3% for the antral resection group and 85% for the antral preservation group. The difference between the two groups was not statistically significant (P>0.05). As for the type of morbidities, both hypertension and dyslipidemia showed fair improvement from the preoperative period in all of the patients. The improvement of comorbidities was further divided to complete and partial resolution, and our data showed that the frequency was equal between groups with frequency of 50% for complete resolution and 50% for partial resolution within each group. Table 5 shows the difference in resolution rate within each comorbidity between the two groups.

Resolution of comorbidities

Postoperative gastric emptying

The mean postoperative gastric emptying t1/2 was much delayed in group A, with mean t1/2 of 95.3 min, whereas the mean t1/2 for group B was 30.85 min, and the difference between the groups was statistically significant (P=0.02), as shown in Table 6.

Discussion

As the surgeons started to use the LSG purely for weight loss procedures for both severe and mild–moderate obese patients, studies have been centered around three main areas: first, the intraoperative safety compared with other procedures especially in the severe obese patients with a clear advantage to LSG compared with other procedures in this regard; second,

Table 2 The frequency of short-term and delayed complications in each group

Postoperative complication	Type of operation			
	Antral resection		Antral preservation	
	Count	Column (%)	Count	Column (%)
Mortality				
No	20	100.0	20	100.0
Yes	0	0.0	0	0.0
Postoperative vomiting				
No	17	85.0	18	90.0
Yes	3	15.0	2	10.0
Postoperative bleeding				
No	17	85.0	19	95.0
Yes	3	15.0	1	5.0
Postoperative respiratory tract infection				
No	19	95.0	19	95.0
Yes	1	5.0	1	5.0
Development of GERD				
No	15	75.0	18	90.0
Yes	5	25.0	2	10.0
Iron-deficiency anemia				
No	16	80.0	18	90.0
Yes	4	20.0	2	10.0
Hypocalcemia				
No	18	90.0	19	95.0
Yes	2	10.0	1	5.0
Vitamin b12 deficiency				
No	17	85.0	19	95.0
Yes	3	15.0	1	5.0

GERD, gastroesophageal reflux disease.

Table 3 Mean±SD showing percentage of excess weight loss within each group at 3, 6, and 12 months

	%EWL 3 months	%EWL 6 months	%EWL 12 months
Antral resection	41.8±19	71.6±22.1	95±24.4
Antral preservation	51±14.5	78.4±14.8	103.2±16.7
Total	46.4±17.3	75±18.9	99.1±21

EWL, excess weight loss.

Table 4 The difference in BMI in each group at 3, 6, and 12 months

Type of operation	Minimum	Maximum	Mean	SD
Antral resection				
BMI before surgery	35	48	40.1	5.7
BMI 3 months postoperative	26	41	34.6	4.9
BMI 6 months postoperative	24	36	30.3	4.3
BMI 12 months postoperative	22	32	26.7	3.6
Antral preservation				
BMI before surgery	35	45	39.5	4.4
BMI 3 months postoperative	27	37	32.6	3.3
BMI 6 months postoperative	24	33	28.6	2.7
BMI 12 months postoperative	22	28	24.8	2.2

short-term postoperative complications (bleeding, mortality, etc.); and third, the long-term sustainability of weight loss and resolution of comorbidities.

There are many things that have been agreed upon by the bariatric surgeons regarding short-term resolution of comorbidities, but also bad outcomes like weight regain and poor weight have been highly reported in several studies [15,16]. Moreover, one of the most factors that make the surgeons choose sleeve gastrectomy is its surgical feasibility, easy to use approach, and shorter time compared with other operations [16].

From the research point of view, the issues that are still present like weight regain, poor weight loss, persistence of weight loss, and long-term resolution of comorbidities need more randomized controlled studies with longer periods of follow-up to ensure the sustainability of the intended outcomes from the LSG. On the contrary, surgeons are trying to improve and modify surgical techniques that might be related and can improve the outcomes and decrease the incidence of poor results occurring after the surgery during the follow-up period.

One of the most debated topics within the context of the LSG is the size of the antrum that will remain after

Table 5 Resolution of comorbidities in each group

	Antral resection			Antral preservation		
	No resolution	Partial resolution	Complete resolution	No resolution	Partial resolution	Complete resolution
HTN	0	1	2	0	3	1
DM	1	3	3	1	2	3
Dyslipid.	0	2	1	0	1	1

DM, diabetes mellitus; Dyslipid., dyslipidemia; HTN, hypertension.

Table 6 The mean of postoperative gastric emptying in each group

	Postoperative gastric emptying (t1/2)				
Type of operation	*N*	Minimum	Maximum	Mean	SD
Antral resection	20	62	124	95.30	22.758
Antral preservation	20	22	42	30.85	6.020

the gastrectomy is done also known as distance from the pylorus.

The available studies and data about this topic are still not conclusive and contradictory. Berger and colleagues in their report on the metabolic and bariatric surgeries found that as the distance from the pylorus increases (preserved approach) the weight loss increased. They tried to correlate their findings physiologically to the idea that as the size of the pyloric antrum increases the antral function of passing the food more quickly to the distal tract and absorption of nutrients leads to better satiety and therefore less eating and more weight loss. However, their findings were contradictory to the meta-analysis done by Parikh *et al*. [17], which found that the size of the postoperative antrum did not affect the weight loss.

McGlone *et al*. [14] in their meta-analysis and systematic review that was dedicated specifically toward our topic of interest (antral resection vs. antral preservation in LSG) found that there was a statistically significant difference in weight loss between the two groups at 24 months in favor of the antral resection technique, whereas at 12 months, there was a difference but was not statistically significant. They suggested that this might be due to the smaller size of the gastric pouch in the antral resection technique. Interestingly, they found that the frequency of occurrence of GERD was not higher in the antral resection group. Regarding other postoperative complications, there was no difference between the two techniques [14].

Abdallah *et al*. [18] in their prospective randomized trial on more than 100 patients found that the weight loss at 6, 12, and 24 months was significantly higher in the antral resection group and the postoperative complications was comparable between the two groups with no statistical difference between the two.

Obeidat *et al*. [19] in their retrospective study that included 110 patients, who were divided into two groups (antral resection and antral preservation), found that the %EWL at 3, 6, 12, and 24 months of follow-up was significantly higher in the antral resection group. Moreover, they found that the weight regain at 24 months was significantly higher in the antral preservation group. The limitation of this study is that it was done retrospectively on patient data collected after the surgery was done [19].

Yuksel *et al*. [20] in their retrospective study that included 111 patients found that the size of the antrum had no significant effect on the resultant weight loss of the patients during the follow-up after surgery.

In our study, we found data that agree with some of the aforementioned evidence and others that contradict the data observed by the aforementioned studies. Our data agree with the studies regarding postoperative complications, as there was no significant difference between the two arms of the study, as well as regarding the resolution of the obesity-related comorbidities, as they were high for all of the cases and comparable in the two arms, with no statistical difference.

The weight loss was higher in the antral preservation group at 3, 6, and 12 months postoperatively, but there was no significant difference between the two groups. This finding does not agree with the meta-analysis by McGlone, where they observed long-term weight loss in favor of the antral resection group. However, our findings were comparable to Parikh and colleagues and Yuksel and colleagues, who also found that the size of the antrum did not significantly affect the weight loss after surgery.

The results of our study further highlight the need for stronger and long-term randomized trials to compare between the two techniques in questions, as the data observed can differ between trials and still no definite

stance is taken toward the antral size in LSG for obesity management.

The limitations of our study include relatively small sample size as previous studies were done on a larger number of patients and the relatively short-term follow-up as we highlighted from the literature that there is a need of long-term studies with more than 5 years of follow-up for better analysis and realization of the outcomes of LSG in general.

Conclusions

The surgical approach regarding the size of the antrum does not matter from the safety and postoperative complications point of view, but it is still not clear whether or not there is a difference between antral resection and preservation regarding the weight loss. Our study suggests that there is no significant difference in the weight loss after surgery during the first year of follow-up. The strong significant result is the difference in postoperative gastric emptying, which shows the importance of the pyloric antrum in the physiology of the stomach and might help to clarify future results. Further randomized controlled trials are needed for long-term follow-up of the patients.

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Conflicts of interest

No conflict of interest.

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