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Original Research Article

Relationship between the resected stomach volume and early postoperative weight loss following laparoscopic sleeve gastrectomy

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ABSTRACT

Background: The aim of the study was evaluation of the effect of the resected gastric volume (RGV) on weight loss after laparoscopic sleeve gastrectomy (LSG).
Methods: This prospective study included 40 morbidly obese patients undergoing LSG. Multi Detector Computed Tomography (MDCT) was used to measure preoperative stomach volume and sleeve volume. The actual RGV was measured after surgery. The primary outcome measure was the relation between RGV and percentage of excess body weight loss (%EBWL) after 3 and 6 months. The secondary outcome was early postoperative complications.
Results: The mean preoperative BMI was 43.5±4.3 kg/m^2. The actual RGV was substantially correlated with that estimated by CT (r=0.996, p<0.001). The former was significantly larger with a mean deviation of 17.6 cc (95%CI: 12.2-23.0 kg). The actual and CT-estimated RGV were positively correlated with% EBWL after 3 months (r=0.361, p=0.022 and r=0.471, p<0.001, respectively) and after 6 months (r=0.466, p=0.002 and r=0.553, p<0.001, respectively). Percentage of volume reduction was positively correlated with weight reduction after 3 and 6 months (r=0.0.525, p=0.001 and r=0.564, p<0.001, respectively).
Conclusions: The resected gastric volume during LSG was significantly correlated with weight reduction after 3 and 6 months of surgery. Sleeve volume was not correlated with early weight reduction. MDCT is a reliable method to measure gastric volume before and after surgery.

Keywords: Resected gastric volume, Sleeve gastrectomy, Sleeve volume

INTRODUCTION

The increasing prevalence of overweight and obesity in many countries is designated as a "global pandemic".[1] Obesity is defined as a body mass index (BMI) over 30 kg/m^2, whereas severe or morbid obesity is defined as a BMI over 40 kg/m^2.[2] In adults, the prevalence of overweight and obesity has increased by 27.5% between 1980 and 2013 worldwide.[3] In Egypt, around 36% of the adult population is considered obese.[4]

Bariatric surgery is the only therapeutic option that can achieve reliable, short- and long-term weight loss with significant improvement of associated comorbidities in morbidly obese patients.[5] Sleeve gastrectomy (SG) has gained much popularity to become the second most commonly used bariatric procedure worldwide following R-Y gastric bypass (RYGB). It is, in fact, the most frequently performed procedure in the USA/Canada and in the Asia/Pacific regions.[6] SG rate increased from 5.3% to 27.9% of all procedures between 2008 and 2013 according to the International Federation for the Surgery of Obesity and Metabolic Diseases.[7]

Compared to other restrictive techniques, SG provides better short- and mid-term weight loss and improvement of carbohydrate metabolism.[8] It enhances gastric emptying and accelerates intestinal transit.[9,10] A long-

term study has shown weight regain after SG.[11] This was associated with widening or enlargement of the sleeve after surgery increasing capacity of the gastric tube.[12]

SG entails resection of approximately 80% of the stomach with the remaining gastric capacity of more than 100 ml.[13] Many variants of SG technique have been described. Recently, some technical modifications such as a progressive decrease in gastric remnant size have been made to prevent weight gain in the long term.[8] However, there is no consensus on the stomach volume that should be respected and what size of bougie to use.[9]

The aim of this study was to evaluate the effect of the resected volume of the stomach on weight loss after laparoscopic sleeve gastrectomy.

METHODS

This prospective study included 40 morbidly obese patients recruited from the department of surgery of Cairo University Hospital during the period from March 2017 to September 2017. The study was approved by the research ethics committee of the Faculty of Medicine, Cairo University. All patients provided written informed consents after full explanation of the nature of the procedure and possible complications that could occur during the perioperative period.

The patients were considered eligible if they were morbidly obese adults (18-60 years of age) with a BMI above 40 kg/m^2 or above 35 kg/m^2 associated with co-morbidities. All appropriate non-surgical measures have failed to achieve or maintain adequate, clinically beneficial weight loss for at least six months. Exclusion criteria included severe medical diseases making anesthesia risky, inability or unwilling to change life style after surgery, drugs, alcohol or other addiction, psychological instability, redo surgery, and pregnancy or lactation at screening or surgery.

Preoperatively, all patients were subjected to thorough clinical evaluation and routine laboratory investigations. Preoperative gastric volume was measured by Multi detector computed tomography (MDCT) scan of the upper abdomen. During the operation any operative events or complications were documented. The actual resected gastric volume (RGV) was measured after surgery. Postoperatively, nausea, vomiting and any other complications were recorded as well as concomitant medications.

Follow up visits were scheduled 1, 3 and 6 months after surgery. During each visit, the patient's weight was obtained in addition to nutritional assessment and counseling. Any change in preoperative co-morbidities - if present - was recorded. The sleeve volume was assessed by MDCT within one month after surgery.

Technique

Laparoscopic Sleeve Gastrectomy: Gastric transection begins 3-5 cm proximal to the pylorus till reaching angle of Hiss, over a 36 fr. bougie.

Postoperative assessment of RGV

A small hole was made at the antral end of the resected stomach and filled in slowly with tap water through a barrel of Toomey syringe to allow for the gastric capacitance to accommodate the largest possible volume of water. The filling is stopped when there was no more water flow through the barrel. The stomach is then emptied into a graded container and the amount of water was measured (1). A veress needle is inserted, and the stomach insufflated with air at a pressure of 8 mmHg and a flow rate of 5 liter/min. till the stomach is average distended (2). The volume of resected stomach is measured by calculating the mean of (1) and (2).

Figure 1: Postoperative measurement of resected gastric volume.

Followup

Patients started liquid diet once tolerating and continued for 2 weeks, then encouraged to progress to soft diet for another 2 weeks. Then after 1-month patient could shift to regular diet.

All patients were followed up for early postoperative complications such as bleeding, leakage, superficial and deep infections.

The primary outcome of the study was the relation between RGV and weight loss after 3 and 6 months. The secondary outcome was early postoperative complications. Weight loss was assessed in terms of percentage of excess body weight loss (%EBWL) calculated as EBWL%= (Preoperative body weight – follow-up body weight) / ideal body weight x 100. Ideal body weight=height 2×25/10,000.

CT assessment of preoperative gastric volume and sleeve volume

CT scan was performed using 16 channels MSCT helical SIEMENS Emotion. Low dose MSCT scan was obtained with 1.5 mm slice thickness and 1.5mm slice gap. Post-processing was performed by using Vitrea and Synapse 3D workstations. After 4-6 hours of fasting 20ml of Urographin diluted with water or clear juice in 1:1 ratio is ingested over a 5-minute period. In the supine position CT abdomen is performed in about 10 seconds. Post-processing of the volume axial CT images is performed. Examination post-processing entangles multi-planar reconstruction as well as 3D reconstruction from which the estimated gastric volume is calculated. CT abdomen was done before the operation by an average of 3 days, and within one month after surgery. The resected stomach volume on MDCT was calculated by subtracting the sleeve volume from the preoperative stomach volume on MDCT.

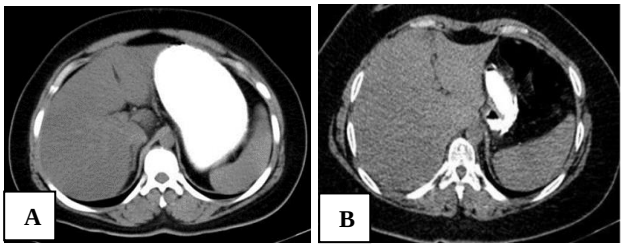

Figure 2 (A and B): Pre and postoperative axial CT image of distended stomach.

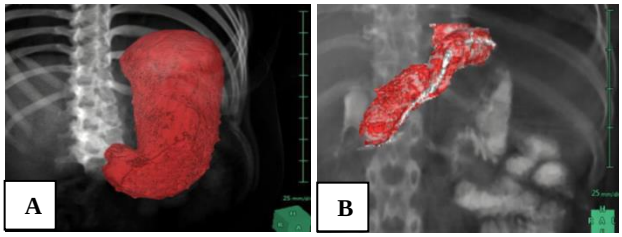

Figure 3 (A and B): Pre and postoperative volume-rendered 3D image of the distended stomach (volume=761,110 cc respectively).

Statistical methods

Statistical analysis was done using IBM© SPSS© Statistics version 22 (IBM© Corp., Armonk, NY, USA). Numerical data were expressed as mean and standard deviation or median and range. Pearson product-moment was used to estimate correlation between numerical variables. Linear regression analysis was used to test magnitude of determination. A $p<0.05$ was considered significant.

RESULTS

The age of the 40 patients ranged between 18 and 53 years with mean of 30.5±8.6 years. Out of the 40 patients, 26 (65%) were females. The BMI ranged between 35.7 and 49.8 kg/m^2 with a mean of 43.5±4.3 kg/m^2. Comorbidities were recorded in 18 patients (45%) in the form of diabetes (n=13), hypertension (n=2), bone and joints comorbidities (n=2) and one patient with diabetes and hypertension. Preoperative anthropometric measurements are showed that the mean BMI=119.7±13.4, the mean deviation from ideal body weight was 52.1 kg (95%CI: 49.3-54.8 kg).

Pre- and postoperative volumes of the stomach and the sleeve are shown in table 1. The actual resected gastric volume (RGV) was substantially correlated with that estimated by CT (r=0.996, p<0.001). The actual RGV was significantly larger than the estimated RGV with a mean deviation of 17.6 cc (95%CI: 12.2-23.0 kg). Using regression analysis, the actual RGV= the CT-estimated RGV × 0.987 + 26.83.

Postoperatively, 4 patients developed port-site wound infection, and 2 patients developed hemorrhage. None of the patients developed leakage. During the 3, 6-months postoperative follow up, %EWL was (28.4±10.5, 48.1±13.3) respectively, significant weight reduction was observed (p<0.001). Weight reduction was significantly higher after 6 months (p<0.001).

Table 1: Perioperative volumes of the stomach and sleeve

	Mean±SD	Median (Range)
Preoperative gastric volume (cc)	830.9±186.3	810.5 (565.0-1170.0)
Actual RGV (cc)	720.0±183.3	680.0 (450.0-1050.0)
Sleeve volume (cc)	128.5±11.9	128.0 (110.0-150.0)
CT-estimated RGV (cc)	702.4±185.0	666.0 (432.0-1035.0)
Percentage of volume reduction (%)	83.8±3.8	84.1 (75.8-88.8)

RGV: Resected gastric volume.

There was a significant positive correlation between the RGV and weight reduction after 3 and 6 months of surgery. Similarly, percentage of volume reduction was positively correlated with weight reduction after 3 and 6 months of surgery.

On the contrary, there was no correlation between the sleeve volume and weight reduction (Table 4). The CT-estimated RGV was positively correlation with% EWL after 3 months (r=0.471, p<0.001) and after 6 months (r=0.553, p<0.001).

Table 2: Correlation between gastric volume variables and outcome of LSG after 3 and 6 months.

	Resected gastric volume		Sleeve volume		Percentage of volume reduction	
	r	p	r	p	r	p
After 3-month						
Body weight (Kg)	-0.247	0.125	-0.032	0.846	-0.228	0.157
Weight reduction (%)	0.474	0.002	-0.153	0.345	0.602	< 0.001
%EWL	0.361	0.022	-0.221	0.171	0.525	0.001
After 6-month						
Body weight (Kg)	-0.095	0.558	0.016	0.920	-0.201	0.214
Weight reduction (%)	0.404	0.010	-0.055	0.738	0.504	0.001
%EWL	0.466	0.002	-0.094	0.562	0.564	< 0.001

r: correlation coefficient

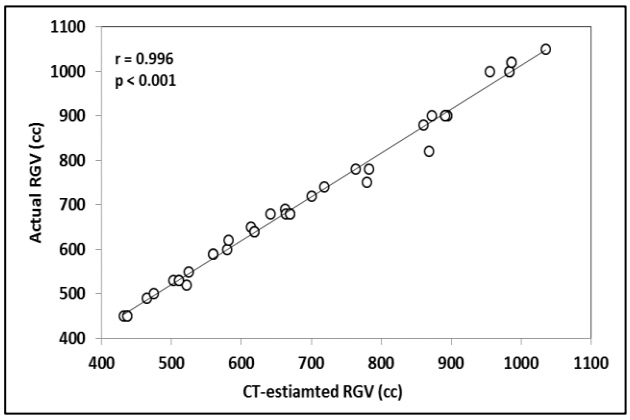

Figure 4: Correlation between the actual RGV and CT-estimated RGV.

DISCUSSION

As a restrictive procedure, LSG reduces the size of the stomach to reach satiety with a small meal. Small sleeve volume leads to rapid distension of the stomach and consequently firing of stretch receptors and feeling of satiety.[14] An additive mechanism is the decrease in levels of ghrelin hormone.[15] But, how much volume to remove from the stomach in LSG is a matter of controversy. A generally accepted method of LSG is removing 80 to 90% of the stomach volume.[16]

The current study tried to find whether the resected gastric volume may impact the short-term outcome of LSG in terms of %EWL. The study demonstrated a significant positive correlation of the preoperative stomach volume, and the resected gastric volume with the magnitude of weight reduction after 3 and 6 months of surgery. On the other hand, sleeve volume was not correlated with weight reduction indices. Therefore, weight loss is affected by how much stomach volume is removed and not how much is left. Accordingly, excessive sleeve narrowing is not necessary to achieve adequate weight loss. Avoiding tight sleeve can abate the chance of complications as delayed leak or stricture.[17]

Weiner et al found that early weight loss was not affected by sleeve size.[12] They found no difference between procedures done with a calibration tube of 32 or 44 Fr. The bougie size used in the current study was 36 Fr for all patients. Like gastric volume to be removed, there is no consensus about the ideal size of the intragastric calibration guide. Nevertheless, it was shown that a bougie size above 40 Fr was associated with poor performance and adjustment below 36 Fr does not lead to better weight loss results.[18] In line with the current study, a recent study found that the volume of the excised stomach but not the sleeve volume was correlated significantly with weight loss after 3 months of LSG.[19] The results contradicts other studies that reported a correlation between increase in gastric reservoir volume and a lower weight loss.[20]

However, the goal of LSG is long-term treatment of morbid obesity. It is claimed that the remaining gastric tube dilates during follow-up with consequent weight gain.[11,12] Nevertheless, in a recent retrospective study, excess BMI loss at 3 months with correlated with that after 24 months. These results confirm consistent long term outcome regarding weight loss.[21] Moreover, a prospective study of 105 patients confirmed our results after longer follow up.[22] The authors reported RGV predicts the %EWL up to 36 months after LSG.

Therefore, the current results assume that the RGV may predict long-term weight loss. It can be added to other suggested predictors in a larger prospective study with a follow up of at least two years. Many studies have revealed other factors to predict long-term weight loss after LSG. Size of the bougie and distance of resection from the pylorus are among these predictors.[23,24] Also, preoperative weight loss, nutrition habits and physical fitness adjustments have been shown to be associated with the success of LSG.[25,26]

In the current study, we used MDCT for preoperative measurement of gastric volume. Other methods have been used to estimate gastric volume such as instillation of normal saline or methylene blue, and UGI contrast series.[12,20,27,28] MDCT was previously shown to be a

reliable estimator of gastric volume before and after LGS. 19, 29 In the current study, the CT-estimated RGV was an accurate predictor of the actual volume resected (R^2=0.992).

In the current study the total stomach volume estimated by MDCT is smaller than that reported in other studies.[19,22] It was suggested that removing a gastric volume less than 500 cc appears to predict procedure failure or early weight regain.[12] Based on this variation, author can say it is the percentage of stomach volume reduction and not simply the absolute resected stomach volume that can predict outcome. In the current study, gastric volume reduction ranged between 75.8% and 88.8% with a mean of 83.8±3.8%. Percentage of volume reduction correlated strongly with weight reduction after 3 and 6 months of surgery in the current study. Therefore, considering individual variations, removing around 80% of the stomach volume may be associated with good outcome in terms of postoperative weight loss.

Author can conclude that the findings of this study advocate that postoperative weight loss up to 6 months following LSG correlates well with the resected stomach volume but not with the gastric sleeve volume. Multi detector computed tomography (MDCT) is a reliable method to measure gastric volume before and after surgery.

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