

## Role of CT Gastric Volumetric Study in Sleeve Gastrectomy

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### ABSTRACT

**Background:** obesity continues to be a major public health problem, as defined by a body mass index (BMI)  $\geq 30$  kg/m<sup>2</sup>. Obesity has been associated with an increased hazard ratio for all-cause mortality, as well as significant medical co-morbidity. Indeed, obesity is not only a chronic medical condition but should be regarded as a bona fide disease state. **Objective:** the study aimed at correlation between the operative gastric volume reduction and body weight reduction after surgery. **Patients and Methods:** our study included 30 cases; all were overweight/obese individuals. There were 20 females and 10 males. All patients underwent MSCT abdomen with oral contrast. Post processing in form of multi-planner reformatting and 3D reconstruction was performed to all cases before and 3 months after sleeve gastrectomy.

**Results:** collection and correlation of preoperative and postoperative data, revealed that the percentage of operative gastric volume reduction ranged between 76% and 98% with mean value of about 84%, while the percentage of body weight reduction ranged between 7% and 24% with a mean value of about 15%. The correlation between the body weight and gastric volume measured preoperative in the studied patients was found to be insignificant, which means that the stomach volume doesn't have a direct impact on body weight.

**Conclusion:** MSCT volumetric study of the stomach is the gold standard imaging technique for evaluation of the gastric size in the preoperative and postoperative states in the context of bariatric sleeve gastric surgery.

**Keywords:** CT Gastric Volumetric, Obese, Sleeve Gastrectomy

### INTRODUCTION

Obese individuals are highly stigmatized and face multiple forms of prejudice and discrimination because of their weight. Weight bias translates into inequities in employment settings, health-care facilities, and educational institutions, often due to widespread negative stereotypes that overweight and obese persons are lazy, unmotivated, lacking in self-discipline, less competent, noncompliant, and sloppy. These stereotypes are prevalent and are rarely challenged, leaving overweight and obese persons vulnerable to social injustice, unfair treatment, and impaired quality of life as a result of substantial disadvantages and stigma <sup>(1)</sup>. Many contributing factors for obesity are existing, genetic and physiologic factors, there has been an increasing focus on contextual elements that impact weight-related behaviours and ultimately weight status. Those factors include, but are not limited to, geography, food preferences, physical and social environment, gender, age, cultural identity, and family composition <sup>(2)</sup>.

Bariatric surgery procedures are indicated for patients with clinically severe obesity. Currently, these procedures are the most successful and durable treatment for obesity. Furthermore, although overall obesity rates and bariatric surgery procedures have plateaued, rates of severe obesity are still increasing <sup>(3)</sup>.

Obesity is associated with cardiovascular disease, hypertension, type 2 diabetes mellitus, hyperlipidaemia, stroke, sleep apnoea, liver and gall bladder disease, osteoarthritis, gynaecological problems, periodontal disease, poor school performance, altered pre-pubertal hormones, and

attention-deficit hyperactivity disorder in children. The complications of obesity are profound and potentiate decreased physical activity (PA) and sedentary behaviours contributing to a never-ending spiral of obesity → health consequences → health-limiting behaviours → increasing or maintained obesity <sup>(2)</sup>.

The safety and effectiveness of bariatric surgery have improved. Bariatric surgery is often an option for individuals with a BMI over 40 or those with BMI's at 35 or above with medical comorbidities. However, surgery is often not recommended for adults with a BMI over 70 or for children. Identified benefits include improvement in mental health and physical, sexual functioning, reduction in mortality 5 to 10 years following surgery, weight loss <sup>(4)</sup>.

The role of radiology in gastric bariatric surgery is no longer limited for detection of postoperative complications, but also it extends to evaluate the role of surgical reduction of gastric size in body weight reduction after surgery. MSCT gastric volumetric study is the only method for accurate assessment of volumes of stomach and gastric sleeve after surgery. It ensures exact data concerning gastric volumes and diameters of anastomoses.

### AIM OF THE WORK

The study aims at correlation between the operative gastric volume reduction and body weight reduction after surgery.

### PATIENTS AND METHODS

**Patients:** The study included 30 cases as pathological obesity cases. No age limits were considered.

The study was conducted at Al Hussein University Hospital in the period from August 2018 to July 2019. **Inclusion criteria:** All patients either male or female who were candidates for gastric sleeve surgery for the first time.

**Exclusion criteria:**

- Patients who are candidates for gastric reduction surgery other than sleeve gastrectomy.
- Patients with recurrent weight gain after previous gastric reduction procedure.

**All patients were submitted to the following:**

**Demographic and clinical data collection:** Including patient's name, age, weight (pre and post-operative weight, height, BMI), and past history of related significance.

**Written informed consent:**

An approval of the study was obtained from Al-Azhar University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of the operation.

**Imaging procedure:**

- All patients were told to be fasting for about four to six hours prior to the examination, in order to have an empty stomach during the study to minimize imaging pitfalls as filling defects as well as decreasing the sense of contrast induced nausea.
- The contrast media used is an effervescent emulsion.
- The patient ingests effervescent emulsion gently in a time window of about 5 minutes prior to the start of scanning (The patient drinks on the machine table) to opacify the entire gastric cavity. Rapid ingestion of contrast was found to increase the sense of nausea with no much more impact on the quality of the examination.
- The patient then lies supine on the CT table (feet first) and CT abdomen is performed with a scanning time of about 10 seconds.

- Post processing of the volume axial CT images is then performed on the work station without need for further patient stay in the CT machine.
- Examination post processing entangles multi-planar reconstruction as well as 3D reconstruction from which the estimated gastric volume is calculated on dedicated work stations.
- All patients underwent CT abdomen after the operation by about three months with the same examination items mentioned.
- The patient's body weight is correlated with the patient's gastric volume.

**Equipment:**

- CT scan was performed by using 16 channels MSCT helical PHILIPS Emotion.
- Low dose MSCT scan is obtained with 1.5 mm slice thickness and 1.5 mm slice gap.
- Post processing was performed by using Vitrea and Synapse 3D work stations.

**Statistical analysis**

Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean  $\pm$  standard deviation (SD). Qualitative data were expressed as frequency and percentage.

**The following tests were done:**

- Independent-samples t-test of significance was used when comparing between two means.
- Chi-square ( $\chi^2$ ) test of significance was used in order to compare proportions between two qualitative parameters.
- The confidence interval was set to 95% and the margin of error accepted was set to 5%. The p-value was considered significant as the following:
  - Probability (P-value)
  - P-value  $<0.05$  was considered significant.
  - P-value  $<0.001$  was considered as highly significant.
  - P-value  $>0.05$  was considered insignificant.

**Case presentation**  
**CASE 1**

**Clinical Background:**

31-year-old male obese male (BMI= 39.3) with;

- Preoperative weight = 125 kg
- 3 months postoperative weight = 102 kg
- Preoperative gastric volume= 1.17 L
- Postoperative gastric volume= 113.9 ml
- Weight reduction percentage = 18.4 %
- Gastric volume reduction percentage= 90.2%

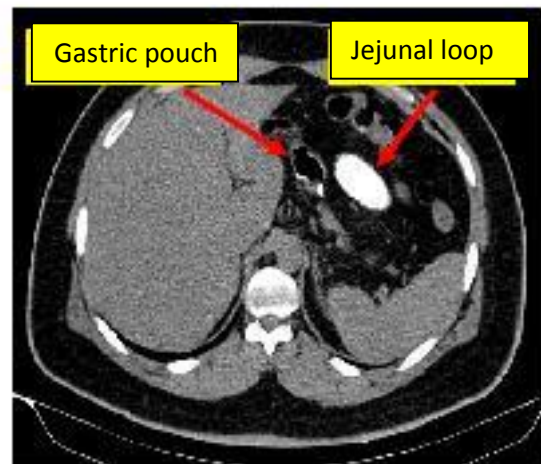
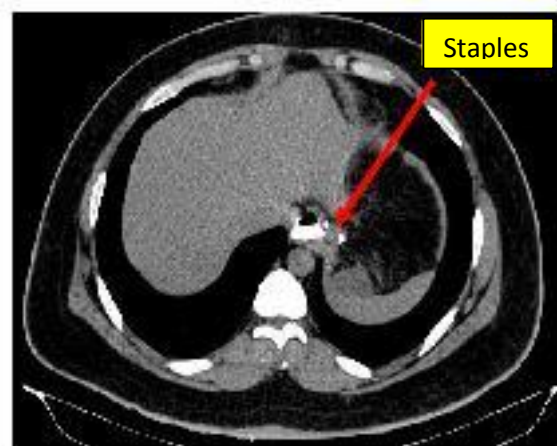
**Findings:**

*Preoperative*

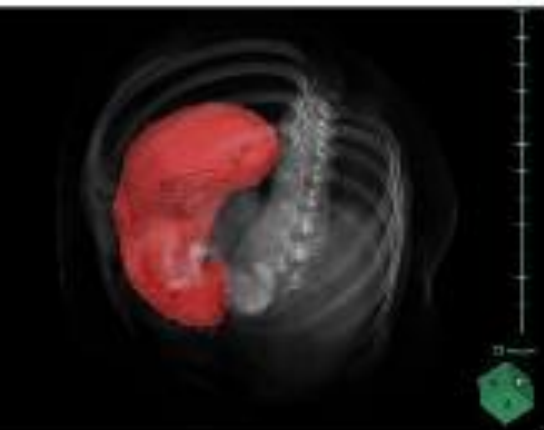
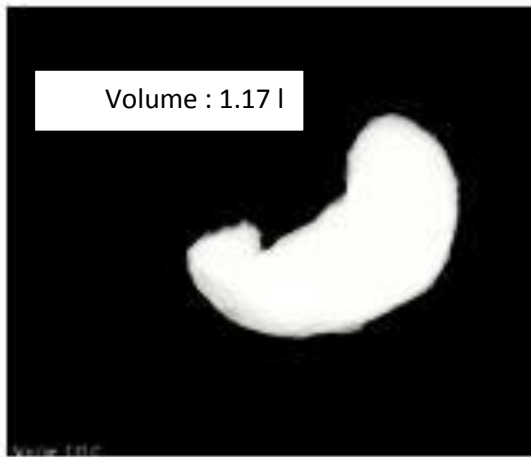


*Preoperative*

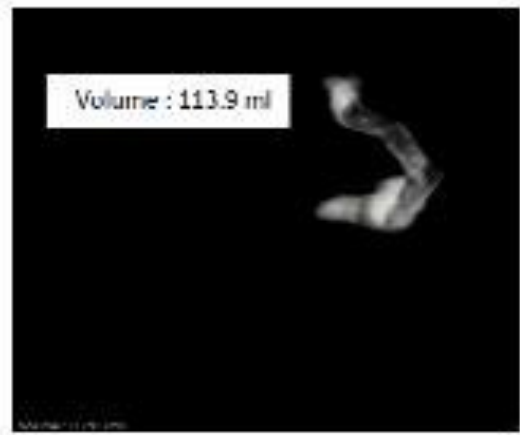
*Postoperative*



*Postoperative*



**Figure (1): Axial volume and 3D reconstruction images of the stomach showing gastric volume = 1.17 L**



**Figure (2): Axial volume and 3D reconstruction images of the stomach showing gastric volume = 113.9 ml (Vol. reduction = 90.2 %)**

**CASE 2**

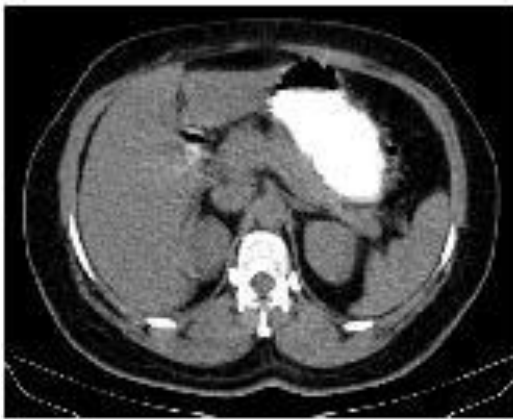
**Clinical Background:**

20-year-old obese female (BMI= 39.1) with;

- **Preoperative weight = 125 kg**
- **3 months postoperative weight = 119 kg**
- **Preoperative gastric volume= 858.4 ml**
- **Postoperative gastric volume= 56.9 ml**
- **Weight reduction percentage = 4.8 %**
- **Gastric volume reduction percentage= 93.3%**

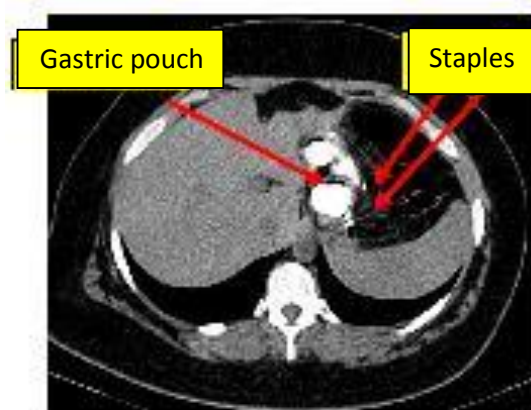
**Findings:**

*Preoperative*



*Preoperative*

*Postoperative*

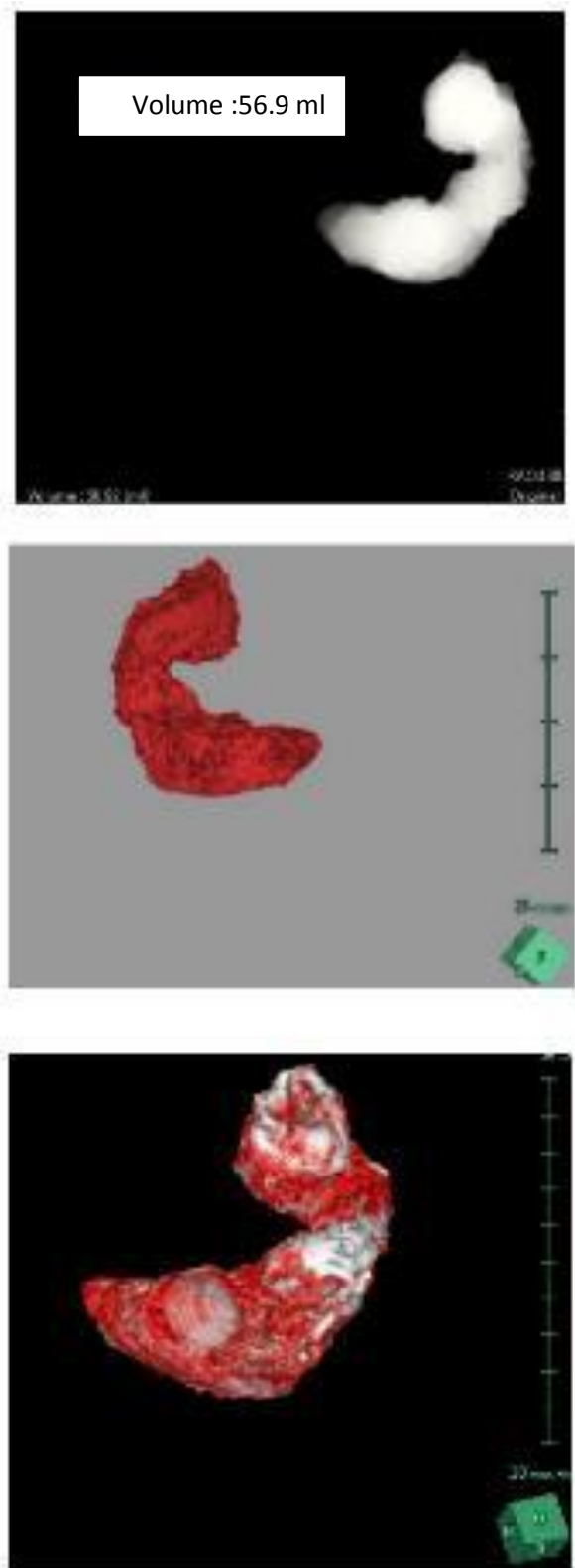


*Postoperative*





**Figure (3):**Axial volume and 3D reconstruction images of the stomach showing gastric volume = 858.4 ml



**Figure (4):**Axial volume and 3D reconstruction images of the stomach showing gastric volume = 56.9 ml  
(*Vol. reduction = 93.3 %*)

**CASE 3**

**Clinical Background:**

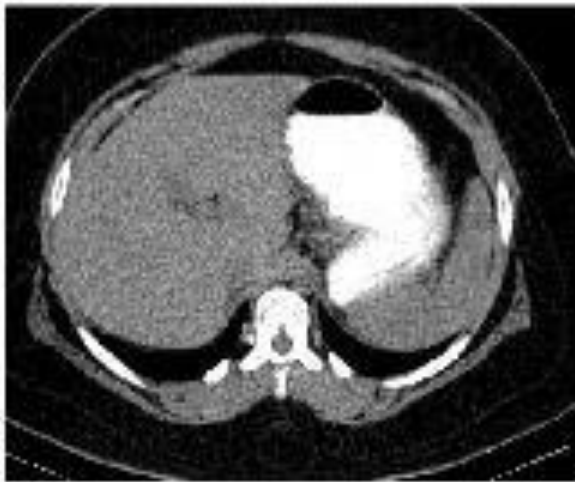
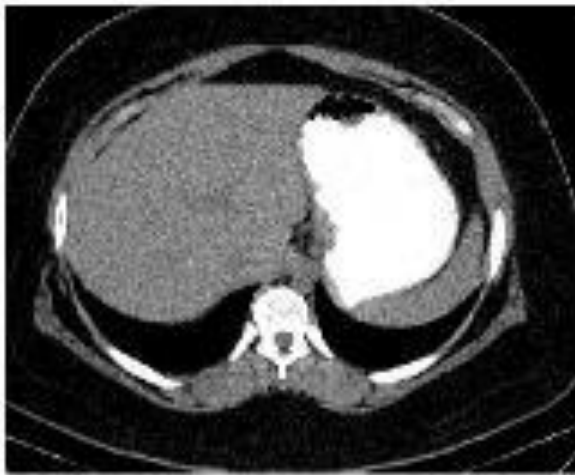
37-year-old obese female (BMI= 42) with;

- **Preoperative weight = 134 kg**
- **3 months postoperative weight = 120 kg**
- **Preoperative gastric volume= 736.3 ml**
- **Postoperative gastric volume= 81.9 ml**
- **Weight reduction percentage = 10.4 %**
- **Gastric volume reduction percentage= 90%**

**Findings:**

*Preoperative*

*Postoperative*



*Preoperative*

*Postoperative*

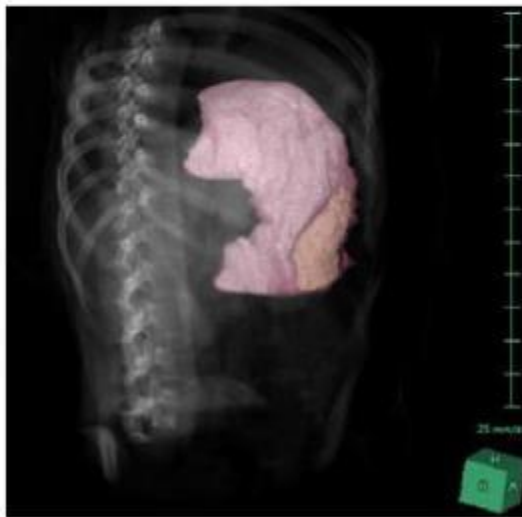
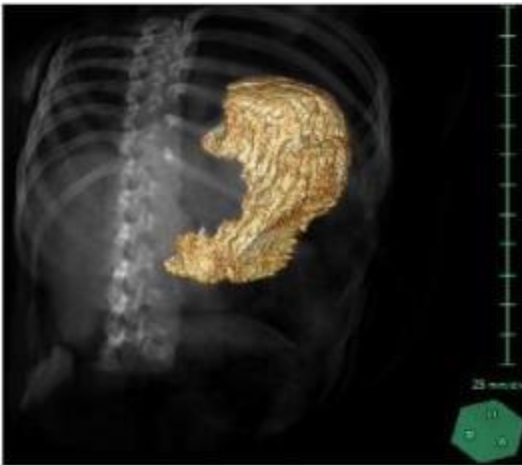
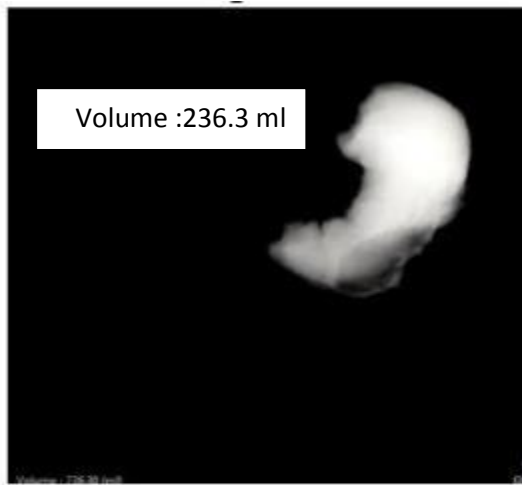


Figure (5):Axial volume and 3D reconstruction images of the stomach showing gastric volume = 736.3 ml

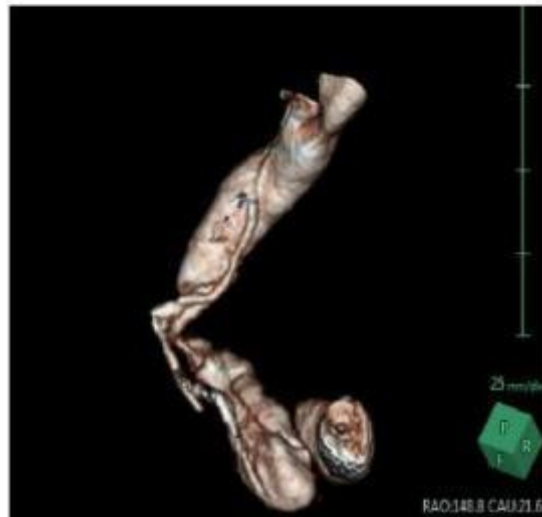
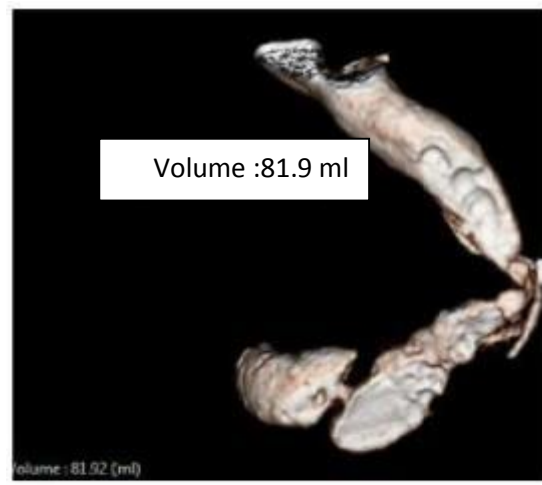


Figure (6):Axial volume and 3D reconstruction images of the stomach showing gastric volume = 81.9 ml (Vol. reduction= 90 %)



**RESULTS**

**Descriptive Statistics:**

**Table (1): Descriptive statistics of the study**

Number (30)	Minimum	Maximum	Mean	Std. Deviation
Age	18.00	53.00	29.93	8.46
Preoperative body weight	82.00	138.00	120.90	13.59
Preoperative gastric volume	525.00	1170.00	800.57	186.31
Postoperative body weight (3 months)	67.00	123.00	102.67	13.12
Postoperative gastric volume (3 months)	110.00	150.00	128.53	12.18
Weight reduction (%)	7.00	24.00	15.07	4.44
Volume reduction (%)	76.00	98.00	83.63	4.52

**Table (2): Demographic features of the studied patients**

	Number	Percent
<b>Age (year):</b>		
Minimum-maximum	18.0-53.0	
Mean ± SD	29.93 ± 8.46	
<b>Gender:</b>		
Female	20	66.7
Male	10	33.3

**Table (3): Comparison between mean values of body weight (kg.) and gastric volume (cc) measured preoperative and 3 months postoperatively in the studied patients**

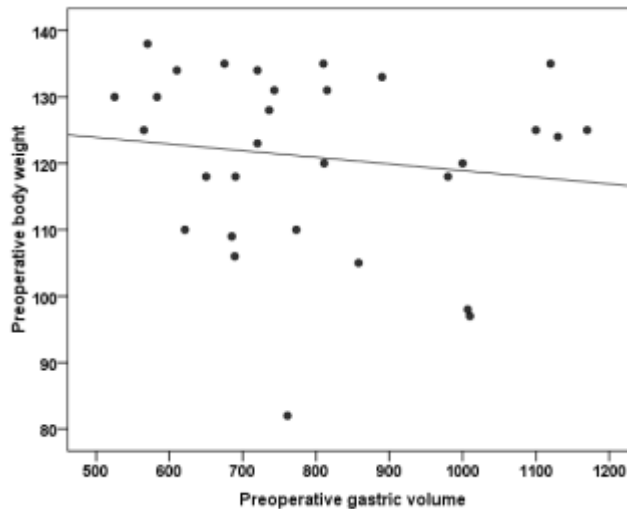
	Preoperative (n= 30)	Three months postoperative (n= 30)	p value
Body weight (kg.)	120.90 ± 13.59	102.67 ± 13.12	0.001*
Gastric volume (cc)	800.57 ± 186.31	128.53 ± 12.18	0.001*

Data are expressed as mean ± SD. \*p< 0.05= significant.

**Table (4): Correlation between body weight and gastric volume measured preoperative in the studied patients.**

	Preoperative body weight	
	Pearson Correlation	P value
Preoperative gastric volume	-0.137	0.470

p> 0.05= not significant.

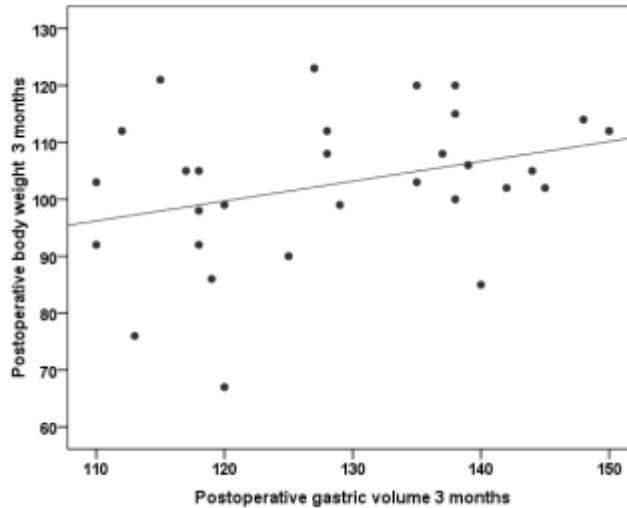


**Figure (7): Correlation between body weight and gastric volume measured preoperative in the studied patients (r= -0.137; p= 0.470).**

**Table (5): Correlation between body weight and gastric volume measured three months postoperatively in the studied patients.**

	Postoperative body weight	
	<i>Pearson Correlation</i>	<i>P value</i>
<b>Postoperative gastric volume</b>	0.323	0.082

p > 0.05= not significant

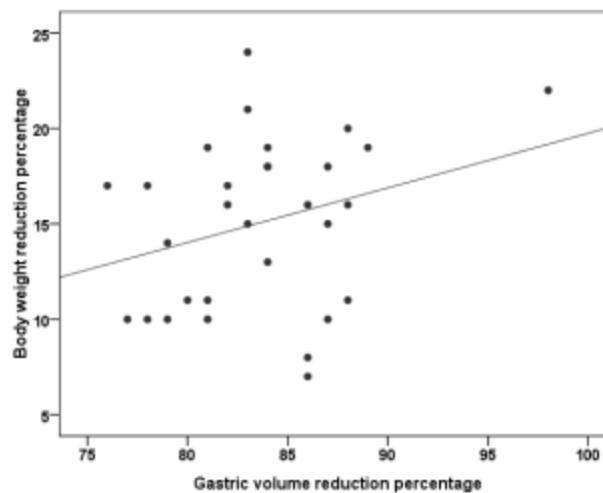


**Figure (8): Correlation between body weight and gastric volume measured three months postoperatively in the studied patients (r= 0.323; p= 0.082).**

**Table (6): Correlation between body weight reduction percentage and gastric volume reduction percentage in the studied patients**

	Weight reduction percentage	
	<i>Pearson Correlation</i>	<i>P value</i>
<b>gastric volume reduction percentage</b>	0.291	0.118

p > 0.05= not significant.



**Figure (9): Correlation between body weight reduction percentage and gastric volume reduction percentage in the studied patients (r= 0.291; p= 0.118).**

## DISCUSSION

MSCT gastric volumetric study is the only method for accurate assessment of volumes of stomach before and after sleeve gastrectomy. Moreover, the form of the pouch can be seen as well as the staples line in detail. Advantages include is the possibility to acquire exact data concerning gastric volumes and diameters of anastomoses, pathologic findings like hernias which might contribute to the patients complains can be seen<sup>(5)</sup>.

Earlier, radiological studies were done to measure the gastric pouch volume in patients claiming weight regain after sleeve gastrectomy, those studies correlated between regain and size of the gastric pouch, but those lacked the initial post-operative gastric volume of the patient.

Then radiological studies were done to measure the early post-operative gastric pouch volume and months after surgery and correlate between changes in gastric pouch volume and changes in weight loss.

Our study included 30 cases; all cases were overweight/obese individuals. There was 20 females and 10 males. All patients underwent MSCT abdomen with oral contrast. Post processing in form of multi-planner reformatting and 3D reconstruction was preformed to all cases before and 3 months after sleeve gastrectomy.

All patients included in the study were suffering obesity with body mass index (BMI) above 30 kg/m<sup>2</sup>. The preoperative body weight ranged between 82 kg and 138 kg with mean value of about 121 kg. The mean preoperative estimated gastric volume ranged between 525 ml and 1170 ml with mean value of about 800 ml.

All patients were re-examined 3 months after the operation. The postoperative body weight ranged between 67 kg and 123 kg with mean value of about 103 kg. The mean postoperative estimated gastric volume ranged between 110 ml and 150 ml with mean value of about 129 ml.

The addition in our study is that we measured the gastric pouch volume after sleeve gastrectomy as included in previous studies; moreover we measured the preoperative gastric volume of all patients, the value of which was to correlate between the operative reduction of gastric volume and reduction in body weight after surgery.

Also in our study, the postoperative assessment of patient's body weight and gastric volume was done three months after surgery, however actually more body weight loss will take place in the next months especially in the first year, however in this short period of time, other factors than gastric pouch volume (i.e. dietary habits) will not have much impact on weight loss.

In our study collection and correlation of preoperative and postoperative data, revealed that the

percentage of operative gastric volume reduction ranged between 76% and 98% with mean value of about 84%, while the percentage of body weight reduction ranged between 7% and 24% with a mean value of about 15%.

The correlation between the body weight and gastric volume measured preoperative in the studied patients was found to be insignificant which means that the stomach volume doesn't have a direct impact on body weight.

The correlation between body weight reduction percentage and gastric volume reduction percentage in the studied patients was found to be insignificant which means that the size of the resected gastric pouch doesn't have direct impact on postoperative weight loss over a three months period.

Limitations in our study included that some overweight individuals exceeded (140 kg) which was incompatible with the used CT machine's table, those were unsuitable for the study. In some postoperative examinations, rapid gastric emptying into the small bowel loops made the gastric pouch partially devoid of contrast during scanning in spite of proper oral contrast administration.

The study of **Weiner et al.**<sup>(6)</sup> could not elucidate a correlation between pouch size on upper gastrointestinal contrast studies and postoperative weight loss, however it stated that large sleeves show short-term weight loss only and the diameter of the gastric sleeve is important for later dilation. A sleeve with a wide diameter will dilate earlier than a tighter one. This emphasizes that the gastric pouch volume does not have a direct impact on body weight and goes with our study results.

In the study of **Ferrer-Márquez et al.**<sup>(7)</sup> that was done on a longer time scale than our study, the volume of the gastric remnant increased significantly during the first year after LSG. However, this increment seems not to affect weight loss. Further prospective studies with longer follow-up are needed to determine whether the apparent increase in gastric volume following LSG does not hinder weight loss maintenance or, on the contrary, slows or even reverses it. This emphasizes that the gastric pouch volume does not have a direct impact on body weight and goes with our study results.

## CONCLUSION & RECOMMENDATIONS

MSCT volumetric study of the stomach is the gold standard imaging technique for evaluation of the gastric size in the preoperative and postoperative states in the context of bariatric sleeve gastric surgery.

Gastric volume does not have a direct impact on body weight in obese individuals.

The percentage of surgical gastric size reduction does not have a direct impact on postoperative weight loss over a three-month period.

Further evaluation of gastric volume and body weight of the studied patients one year after surgery is recommended for continuous observation as well as monitoring the rate of weight loss and incidence of gastric pouch dilatation.

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