

The Role of 3D-MSCT Gastric Pouch Volumetric Study In Sleeve Gastrectomy

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Abstract:

Background: Laparoscopic sleeve gastrectomy (LSG) has now a surge in popularity in treatment of morbid obesity patients. Multi-slice computed tomography has an increasing role in management of this patients' group through the availability and efficiency of post processing reconstructive facilities of MSCT software in 3D reconstruction. The purpose of this study is to evaluate MSCT-based volumetric assessment of stomach and gastric sleeves in patients before and after bariatric surgery and correlation between operative gastric volume reduction and body weight reduction.

Methods: Thirty sleeve gastrectomy-candidate patients received abdominal MSCT immediately after oral administration of an ionic contrast agent solution. The examination was done pre and three months postoperatively. The gastric and sleeve volumes were measured via 3D volume rendering and 3D masks on dedicated workstations.

Results: The correlation between the body weight and gastric volume measured initially in the preoperative state in the studied patients was found to be insignificant. The correlation between body weight reduction percentage and gastric volume reduction percentage in the studied patients was found to be also insignificant.

Conclusion: MSCT allows crucial anatomical measurements and provides helpful information about the relation between gastric volume reduction and body weight reduction in sleeve gastrectomy-candidate obese patients.

Keywords: Bariatric surgery - Laparoscopic sleeve gastrectomy - Multi-slice CT - Volumetric study

Abbreviations:

3D: Three dimensional

MSCT: Multi-slice computed tomography

LSG: Laparoscopic sleeve gastrectomy

BMI: Body mass index

1. Introduction:

Obesity continues to be a major public health problem, as defined by a body mass index (BMI) ≥ 30 kg/m². 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. [1]

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. [2]

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. [1]

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 before and after surgery. It insures 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.

2. Materials and Methods:

We performed a prospective observational study on thirty patients, all consecutive patients undergoing LSG procedures at the Department of radiology of Banha Hospital University from July 2018 to February 2019.

No age limits considered, the study approved by ethical committee of Banha faculty of medicine, and Banha university.

• Inclusion criteria:

All patients either male or female who are candidates for gastric sleeve surgery for the first time with or without gastric bypass.

• 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, (pre and post-operative weight, height, BMI), phone number and past history of related significance.

Informed consent: including procedure description and benefits.

- Equipment:

CT scan was performed by using 16 channels MSCT helical SIEMENS 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 workstations.

- 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 the water soluble (Urographin) with an amount of about 20mLs (One ampoule), it is diluted with water or clear juice (Apple or Pineapple) by about 1:1 ratio, to insure satisfactory contrast density as well as decreasing contrast induced CT artifact.

The patient ingests the diluted contrast media 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 workstation 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 workstations.

All patients underwent CT abdomen before the operation by an average of 3 days, and

also 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 before and after the operation in the mentioned dates.

Statistical analysis

Results are expressed as mean \pm standard deviation (SD), minimum, maximum and number (%).

Comparison between different variables measure preoperative and three months postoperative was performed using paired t test.

Correlation between variables was performed using Pearson correlation coefficient.

Statistical Package for Social Sciences (SPSS) computer program (version 19 windows) was used for data analysis. P value \leq 0.05 was considered significant.

3. Results:

Thirty patients were included in the study. Most of them were female (20 F/10 M), with a mean age of 29.9 (8.4) years, preoperative weight of 138 (120) kg, and preoperative weight of 123 (102) kg/m², (Table 1).

The statistical analysis of the proportion of gastric volume in relation to body weight before & three months after surgery, Gastric volume does not have a direct impact on body weight in obese individuals, (table 2, 3)

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: 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 3: 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

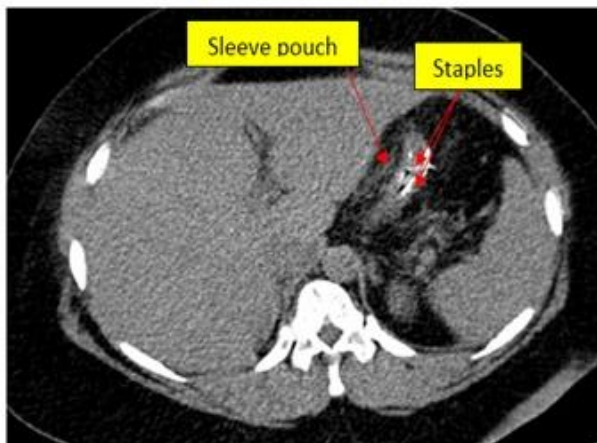


Fig 1: Axial cut CT abdomen showing normal appearance of sleeve pouch after gastric sleeve surgery.

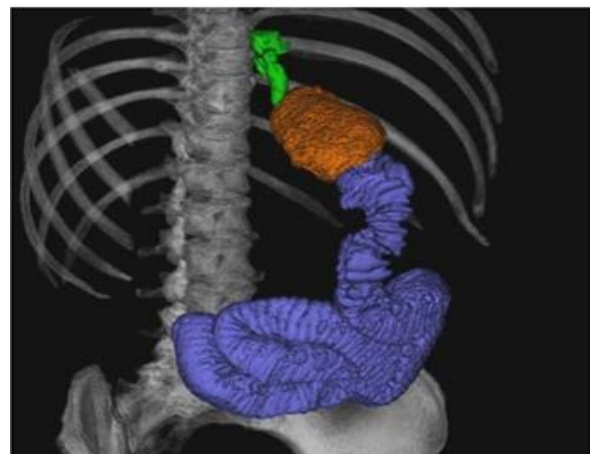


fig 2: 3D volume rendering image after sleeve gastrectomy

4. Discussion:

The prevalence of overweight/obesity is increasing worldwide regardless of how it is measured. There is an increased prevalence of overweight/obesity in developed and developing countries over the past 30 years. [3]

Many contributing factors for obesity are existing, genetic and physiologic factors, there has been an increasing focus on contextual elements that impact weight-related behaviors 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. [3]

Obesity is associated with cardiovascular disease, hypertension, type 2 diabetes mellitus, hyperlipidemia, stroke, sleep apnea, liver and gall bladder disease, osteoarthritis, and gynecological problems, periodontal disease, poor school performance, altered pre-pubertal hormones, and attention-deficit hyperactivity disorder in children.

The American Medical Association designation of overweight/obesity as a disease necessitating appropriate medical treatment contributed to a major shift in approaches to intervention. Increasingly, medications and bariatric surgery are considered to help combat this epidemic. Drugs include

(phentermine, diethylpropion, phendimetrazine, benzphetamine). A recent systemic review highlights that although these drugs are safer than older drugs, the extensive side effects or risks (e.g., gastrointestinal disturbances, insomnia, headaches, cognitive problems,) limit potential success. [4]

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. [4]

Laparoscopic sleeve gastrectomy (LSG) is an emerging surgical approach, it has a surge in popularity because of its perceived technical simplicity, feasibility, and good outcomes. LSG has become the ideal operation for patients with BMI >55, for treating morbidly obese patients with severe medical conditions, as an excellent alternative to adjustable bands in lower BMI patients. [5]

Concomitantly with the growing number of bariatric operations, the bariatric surgeon is also faced by a rising number of patients in possible need for revisionary surgery. Most often, revisions are indicated due to

insufficient weight loss or weight regain. A variety of methods have been proposed for measurement of pouch volumes. Most commonly, fluoroscopy with contrast swallows is used to evaluate pouch sizes, but to allow a more accurate evaluation of pouch sizes, MSCT with oral contrast and subsequent data processing on a 3D workstation is of choice. [6]

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. [6]

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/m². 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

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 month 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 "Laparoscopic Sleeve Gastrectomy – Influence of Sleeve Size and Resected Gastric Volume" Weiner et al, 2007 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 "Changes in gastric volume and their implications for weight loss after laparoscopic sleeve gastrectomy" Márquez et al, 2016 which 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.

5. Conclusions & 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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