Original Article

Comparative study between laparoscopic sleeve gastrectomy and laparoscopic greater curvature gastric plication regarding reduction in gastric volume using computed tomography gastric volumetry

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ABSTRACT

Background: The most effective therapy for obesity is bariatric surgery. In addition to weight loss, it also significantly reduces mortality and improves comorbidities associated with obesity within a significant proportion of patients. Laparoscopic sleeve gastrectomy (LSG) and laparoscopic greater curvature gastric plication (LGCP) are both restrictive bariatric surgeries. LSG is considered the most performed worldwide. We aimed to compare the residual gastric volume (RGV) after LSG and LGCP and correlate this volume with weight loss.

Patients and Methods: This was a comparative cohort study performed on 40 obese cases assigned into two groups. Group A underwent LGCP and group B underwent LSG. All cases in both groups underwent multislice computed tomography gastric volumetry after 3 months to assess RGV. The excess weight loss percentage (EWL%) was subsequently correlated with the RGV 6 months' postsurgery.

Results: In this study, group A had a significantly higher average of RGV in comparison to group B (357.9±79.9 vs. 132.4±44.4, *P<0.001*). Group A had higher EWL% in comparison to group B (59.1±17.7 vs. 52.5±9.1, *P=0.076*).

Conclusion: RGV might be able to predict the EWL% following LGCP and LSG. The less the RGV, the greater the EWL%. LGCP is an effective operation for weight loss despite relatively high RGV.

Key Words: Excess weight loss, plication, residual gastric volume, sleeve.

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INTRODUCTION

One of the most prevalent causes of avoidable mortality on a global scale is obesity. The 18th highest prevalence of obesity in the world is in Egypt, according to the WHO. Deaths attributable to noncommunicable diseases represent about 71% of the total mortality burden[1].

Pharmacotherapy, lifestyle modification, and bariatric surgery are the primary therapeutic methods that have a sufficient amount of evidence-based support[2].

The most effective treatment for morbid obesity and obesity-related comorbidities is now undisputedly bariatric surgery. Surgical therapy has been demonstrated to produce considerably superior weight reduction results compared to medicinal treatment, as well as superior resolution or improvement of obesity-related comorbidities, including hypertension, dyslipidemia, and type 2 diabetes, in several clinical trials[3].

Bariatric surgeries induce loss of weight by at least two pathways, and there are likely several other mechanisms that are yet to be identified. The most common mechanism is restriction of dietary intake. Malabsorption of ingested food is the second mechanism. Most procedures achieve weight loss by a combination of the mechanisms. However, each procedure relies mainly on one mechanism more than the other[4].

Both laparoscopic sleeve gastrectomy (LSG) and laparoscopic greater curvature gastric plication (LGCP) are restrictive procedures, with LSG being the most commonly performed metabolic surgery[5].

The objective of restrictive bariatric surgery is to decrease food intake by decreasing the stomach volume, so eliciting a sense of fullness at an earlier stage[6]. The effects of many restrictive bariatric operations have been worsened by an extremely high residual gastric volume (RGV), as demonstrated by several research[7].

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A range of procedures, including fluoroscopy with contrast swallows and endoscopic approaches, have been suggested for the measuring of pouch volumes. However, their limited value is due to their invasiveness and poor quantitative volumetric measures[8].

The RGV has been assessed using a multislice computed tomography (MSCT)-based volumetric assessment of gastric pouches[9].

The correlation between the excess weight loss (EWL) and the RGV after both operations can be beneficial in forecasting the loss of weight following procedure and aiding in the subsequent evaluation of the success or failure of the procedure[10].

We aimed to compare the RGV after LGCP and LSG and correlate this volume with the weight loss.

PATIENTS AND METHODS:

This comparative cohort study was performed on 40 morbidly obese cases, aged more than 14 years with BMI above 35 kg/m^2 with or without any medical comorbidity or with BMI ranging from 30 to 35 kg/m^2 with any medical comorbidity, with upper limit of BMI 45 kg/m^2 for patients who underwent LGCP, who were psychologically stable, had no endocrinal causes for obesity, underwent sufficient nonsurgical trials to reduce weight, and were motivated and accepted of surgical risks.

After receiving clearance from the ethics committee (approval code: MS-385-2023) and getting informed consent, this study was conducted at Cairo University hospitals from September 2023 to April 2024 both verbal and written, from all cases, including approval of treatment protocol.

We assigned the cases into two groups by systematic allocations; group A underwent LGCP. group B underwent LSG.

All cases had a comprehensive clinical preoperative examination and investigations. Clinical evaluation aimed to detect various morbid obesity complications such as history of psychotherapy, diabetes mellitus, hypertension, sleep apnea, infertility, skeletal problems, hernias, preoperative evaluation, and to assess the degree of obesity. Additionally, the patients received laboratory examinations (fasting blood sugar, complete blood count, coagulation profile, liver functions, renal functions), pulmonary assessment by pulmonary functions tests and chest radiograph, glycated hemoglobin, and thyroid-stimulating hormone, HCV ab, and HBV Ag, and cardiac evaluation (echocardiography and ECG if needed).

Demographic data, height, body weight, and BMI, obesity comorbidities information were obtained. Change of obesity comorbidities categorized according to symptoms and need for medications into four grades: worsened, the same, improved, or controlled/cured. All the surgeries were performed by the same operator, recording the intraoperative time and any intraoperative complications.

The postoperative patients' visits were as follows

Visit 1 included screening and preoperative assessment, informed consent, a determination that patient meets all the screening inclusion criteria and presents none of the preoperative exclusion criteria, demographic information review, participant medical and surgical history, concomitant medication review, participant physical examination such as vital signs, weight, and height measured using a calibrated scale, blood tests, abdominal ultrasound, pulmonary function tests, chest radiograph, cardiac evaluation (echocardiography, ECG).

Visit 2 was 1 week postoperative. It included searching for any postoperative complication and checking the hydration state of the patient.

Visit 3 was 3 months' postoperative. It included MSCT gastric volumetry, assessment of weight reduction, and estimated weight loss.

Visit 4 was 6 months' postoperative. It included assessment of weight reduction and estimated weight loss.

Surgical technique

Laparoscopic sleeve gastrectomy

Under general anesthesia, standard placement of the patient on the operating table was implemented in a 30^o French position (with the operator positioned between the legs) in a reversed-Trendelenburg position, and two assistants on either side of the patient.

Trocar placement was as follows: 12 mm trocar in the left upper quadrant midclavicular line, 10 mm trocar in the left to midline, camera port was placed supra umbilical, a 12 mm trocar is positioned at or slightly above and to the right of the umbilicus (parallel to the stomach's lesser curvature), 5 mm trocar for the assistant port in the left upper quadrant, anterior axillary line. In the subxiphoid area, a liver retractor was placed.

The greater omentum was divided 5 cm proximal to the pylorus at the incisora angularis to start dissection. Using an energy instrument (harmonic scalpel or LigaSure vessel ligation system), the gastroepiploic vessels were separated along the greater curvature toward the short gastric vessel, which was also divided. This dissection was continued in order to split the gastrophrenic ligament fully and mobilize the angle of His to find the left crus of the diaphragm.

Dissection of the omentum was continued to a distance of 2–6 cm from the pylorus.

The stomach was grabbed and lifted anteriorly to reveal its posterior wall, following the detachment of the omentum from the greater curvature, providing access to the lesser sac. We removed all adhesions to the lesser sac until we reached the lesser curvature at the most medial portion of the stomach.

The 32–40 French bougie (median is 36 French) was positioned under laparoscopic visualization and directed to a spot distal to the divided omental attachments after removing the orogastric tube.

This was accomplished by employing an endoscopic stapler that was 60 mm in length. Firing commenced at a position along the bougie, ~5 cm proximal to the pylorus, and at an angle that was parallel to the lesser curvature. To prevent the sleeve from "spiraling," it is necessary to ensure that the stapler covers the anterior and posterior stomach in similar lengths. Sequentially firing staple lines down the bougie toward the angle of His, the fundus was divided at a distance of 2 cm lateral to the esophagus. The 12 mm port was then used to extract the amputated stomach.

Staple line reinforcement: the primary goals of staple line support are to decrease the rates of staple line leakage and hemorrhage. Vicryl 2/0 continuous inverting sutures were taken over the gastroesophageal junction, then oversewing over the remaining part of the staple line.

The staple line's integrity was evaluated using methylene blue, while the pylorus was squeezed using a surgical grasper. The staple line was meticulously examined to rule out macroscopic leakage of the suture line after methylene blue was introduced into the stomach using the bougie. The bougie was also removed, as was the dye from the stomach. In order to prevent hernias of the abdominal wall, 0 vicryl (Ethicon) was used to close all trocar sites using a suture passer.

Laparoscopic greater curvature gastric plication

Standard placement of the patient on the operating table was implemented in a 30^{o} French position (with the operator positioned between the legs) in a reversed-Trendelenburg position, and two assistants on either side of the patient. Standard trocar positioning was also implemented. A five-trocar port approach was employed to create a closed pneumoperitoneum. Trocar placement as follows: for the 30 telescope, one 10 mm trocar was positioned slightly to the left and above the umbilicus; in the upper left quadrant, there is a single 10 mm trocar that is used for the surgeon's right hand, suturing, and the passage of the needle; for the surgeon's assistant, one 5 mm trocar is additionally located in the upper left quadrant below the 10 mm trocar at the anterior axillary line; for liver retraction, one 5 mm trocar is inserted below the xiphoid process; additionally, for the surgeon's left hand, a 5 mm trocar in the upper right quadrant was placed.

The first part of the surgical technique in LGCP is exactly similar to LSG till devascularization of the stomach's entire greater curvature (except for the distal 4 cm) but with a few millimeters far from the edge of the stomach to avoid thermal injury to the gastric wall by the harmonic. The plication was initiated 1–2 cm from the angle of His and progressed to 5–7 cm from the pylorus over a 36 Fr after releasing the greater curvature. Boogie uses full-thickness running suture line of 2-0 polypropylene starting from point (b) then to point (a) on the posterior stomach wall then to the greater curve then to point (a), and finally point (b) on the anterior stomach wall then go back to point (b) on the post wall repeating the same steps till reaching point 5–7 cm from pylorus, it was not only a simple invagination it was a real plication. The suture material was then knotted, and a second running suture line was applied, ending at the angle of His. Anteriorly and posteriorly, the space between each stitch and lesser curvature was 2 cm. Additionally, the spacing between each stitch and the subsequent stitch was 2 cm. A large sleeve gastrectomy-shaped stomach was the outcome of the reduction. Full-thickness suture bites were used to secure the plication.

Follow-up of patients

All cases in the postoperative period were given third-generation cephalosporins, anticoagulants, antiemetics, proton pump inhibitors, and opioids. If tolerated, oral fluids were started in all patients. Following satisfying the discharge criteria of no leaking, no bleeding, and no additional problems, all cases were discharged on day 1 or 2. All patients continued on oral fluids for 1 week, followed by semisolids for one more month.

Outpatient follow-up was conducted for all patients for a period of 6 months. At the conclusion of the third postoperative month, CT volumetry was performed on all patients to correlate the effect of the original postoperative gastric tube size to the EWL% after the performance of both surgical techniques as the size of gastric tube size may differ significantly with time.

Computed tomography volumetry

Patients preparation

On a MSCT 64-section detector scanner (GE), a plain abdomen CT was conducted (General Electric Medical Systems, Milwaukee, Wisconsin, USA). The study was conducted with all patients having fasted for a minimum of 8 h. Each patient was orally supplied two packs of effervescent granules in 10 ml of water before the CT examination. The patients were positioned in a supine position on the scanning table. A scout projection is subsequently acquired, demonstrating that the stomach is completely distended by gas. Another pack is supplied orally to guarantee that the stomach is sufficiently dilated if the stomach is insufficiently dilated. In order to guarantee that the stomach was completely distended, a delay of 10–15 s was necessary.

Computed tomography protocol

A single breath-hold was used to acquire images from a level 1–2 cm below the diaphragm's dome to the lower pole of the right kidney. The helical CT data acquisition parameters were 600–700 mA, 120 kVp, 5 mm reconstruction interval, 1.25 mm collimation, and 0.7 s rotation time. Imaging was accomplished within the breath-hold time by acquiring all images within 30–40 s.

At 0.5-mm intervals, the 1.25-mm transverse CT sections were rebuilt using a commercially available workstation (Advantage Windows 3.1; GE Medical Systems). A built-in cursor was employed to trace the contours of all stomach parts. In LSG patients, the initial segment of 3D reconstruction for volumetry commences at the most proximal radiodense staple and extends to the pyloric ring (Fig. 1).

For LGP, the gastroesophageal junction is the approximate location of its onset. The manufacturer's workstation, which was equipped with specialized software, automatically determined the number of pixels contained inside the traced outlines of each part and delivered the cross-sectional area of the stomach on a section-by-section basis. The circumscribed regions were thereafter automatically multiplied by the thickness of the CT slice, resulting in an approximate volume for each stomach section. The sum of the volumes of all sections was then calculated to determine the selected stomach volume (Fig. 2).

Statistical analysis

The results were analyzed using SPSS (Statistical analysis was done using IBM SPSS statistics for windows, Version 28.0. Armonk, NY: IBM Corp). Frequencies and percentages were utilized to represent qualitative variables. Relation between qualitative data was done using the χ^2 test. The mean and SD. The data's normality was determined using the Kolmogorov–Smirnov single-sample test. The comparison between the two numerical groups was done using the Mann–Whitney test. Comparison between pretreatment and posttreatment was done using the related-samples Wilcoxon signed rank test. Results were deemed significant when the two-tailed *P value* was less than 0.05.

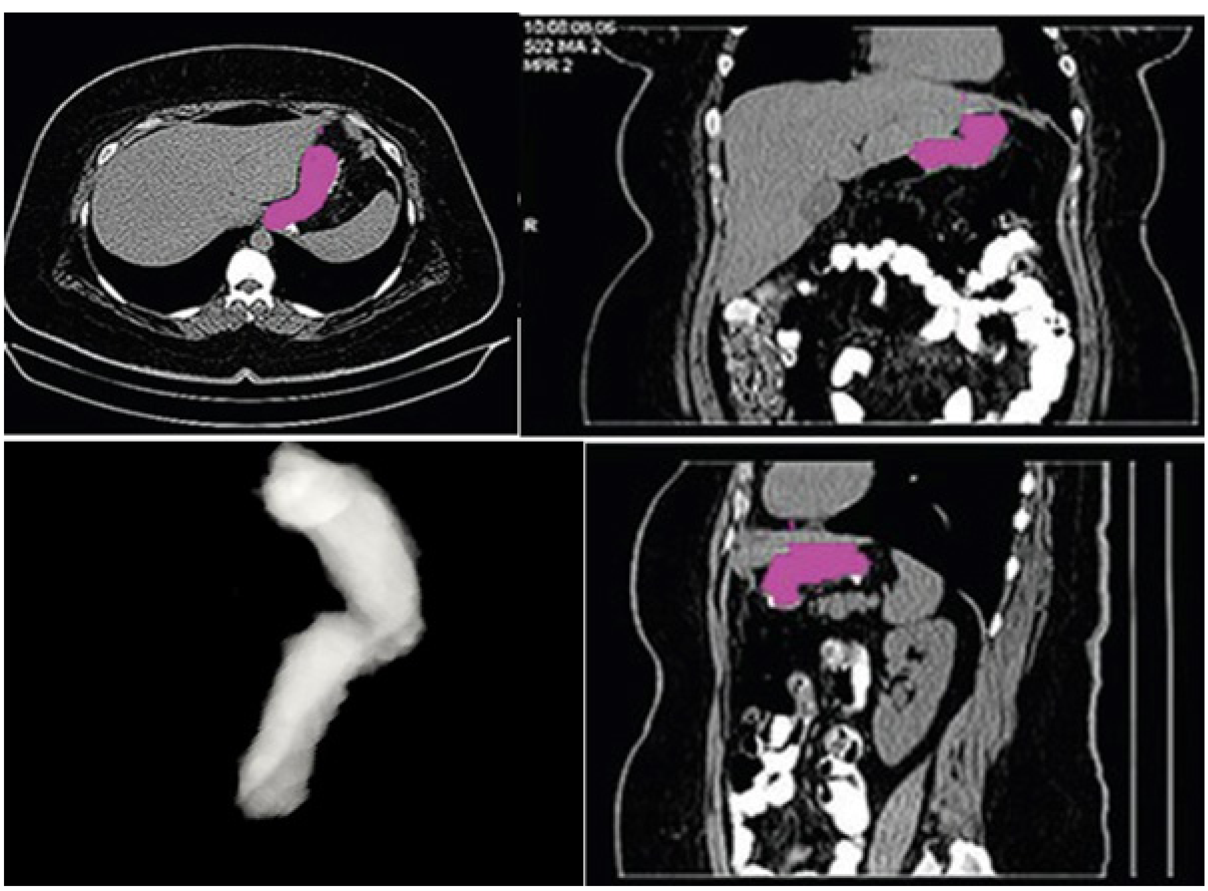

Fig. 1: Computed tomography volumetry for gastric sleeve.

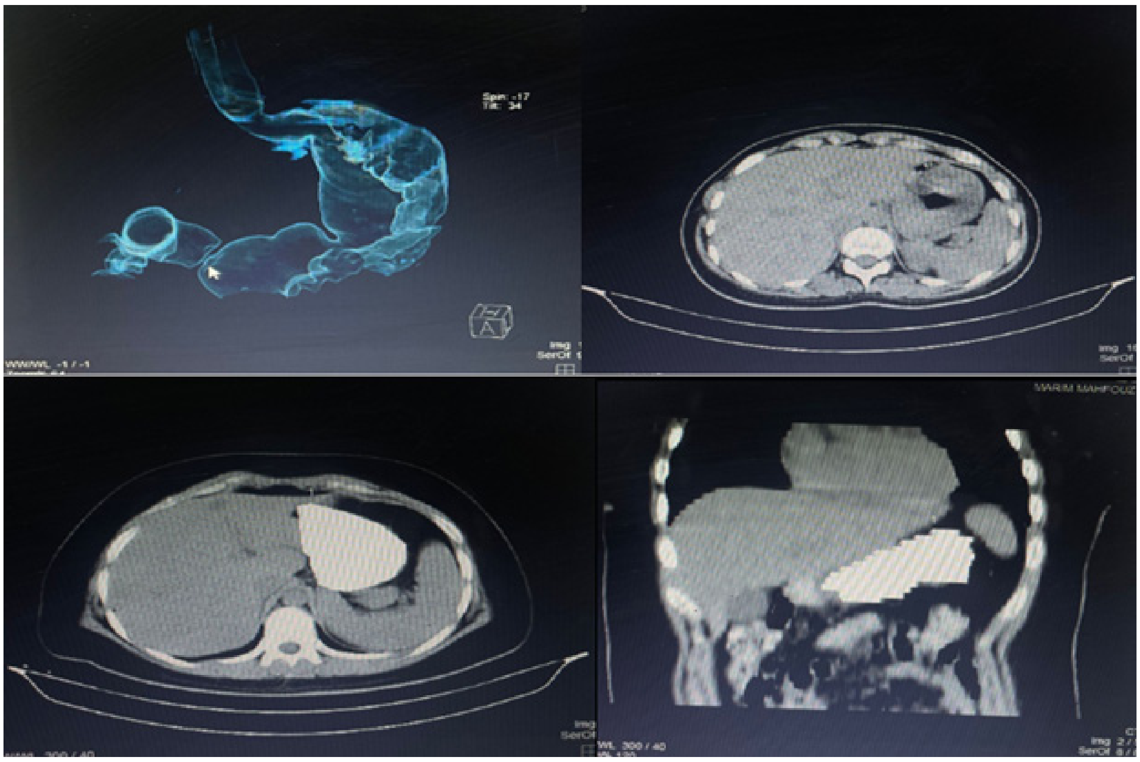

Fig. 2: Computed tomography volumetry for gastric plication.

RESULTS:

Table 1 shows the average age of the participants was 30.4±6.8 years and LSG participants were significantly younger than LGCP participants (*P=0.001*). Most of the cases were females with insignificant variation between groups as regards sex. A significantly lower average weight and BMI was reported in the LGCP participants in comparison to the LSG group (*P<0.001*). However, insignificant variation was reported between groups as regards height.

A significantly higher average postsurgery weight and BMI was reported in the LSG group compared to the LGCP group (*P<0.001*). An insignificant difference between groups was reported regarding ideal weight and estimated weight loss% 6 months post. A significantly higher average of RGV was reported in LGCP in comparison to LSG (*P<0.001*; Table 2).

In group LGCP, a significant decrease in weight and BMI posttreatment was reported in comparison to pretreatment (*P<0.001*). In group LSG, a significant decrease in weight and BMI posttreatment was reported in comparison to pretreatment (*P<0.001*; Table 3).

Figure 3 shows the correlation between each patient's RGV after 3 months and EWL% after 6 months in group A.

Figure 4 shows the correlation between each patient's RGV after 3 months and EWL% after 6 months in group B.

Table 1: Sociodemographic characteristics, preanthropometric measures, and operative time of the studied patients

Characteristics	LGCP (*N*=20)	LSG (*N*=20)	*P* value
Age (years)	34±7	27±5	0.001*
Sex			
Female	20 (100)	16 (80)	
Male	0	4 (20)	0.106
Weight (kg)	101.4±6	127.2±7.2	<0.001*
Height (cm)	161.3±3.8	160.1±3.3	0.341
BMI (kg/m^2)	39±2.1	49.6±2.4	<0.001*
Operative time (min)	67±41	56±27	0.143

Data are presented as mean±SD or frequency (%).
LGCP, laparoscopic greater curvature gastric plication; LSG, laparoscopic sleeve gastrectomy.
*Statistically significant as *P value* less than or equal to 0.05

Table 2: Comparison of anthropometric measures postsurgery and residual gastric volume by computed tomography gastric volumetry between the two groups

Characteristics	Total (*N*=40)	LGCP (*N*=20)	LSG (*N*=20)	*P* value
Weight 6 months post	87.3±10.7	80.4±8.5	94.3±8.0	<0.001*
Ideal weight	64.4±2.6	65.0±3.1	63.7±2.1	0.183
Estimated weight loss % 6 months post	55.8±14.2	59.1±17.7	52.5±9.1	0.076
BMI 6 months post	33.8±4.2	30.9±2.8	36.8±3.1	<0.001*
RGV	245.1±130.8	357.9±79.9	132.4±44.4	<0.001*

LGCP, laparoscopic greater curvature gastric plication; LSG, laparoscopic sleeve gastrectomy; RGV, residual gastric volume.
*Statistically significant as *P value* less than or equal to 0.05.

Table 3: Comparison of preanthropometric and postanthropometric measures in group laparoscopic greater curvature gastric plication and in group laparoscopic sleeve gastrectomy

	LGCP		
	Pre	Post	*P* value
Weight (kg)	101.4±6	80.4±8.5	<0.001*
BMI	39±2.1	30.8±2.9	0.001*
	LSG		
Weight (kg)	127.2±7.2	94.3±8.0	<0.001*
BMI	49.6±2.4	36.8±3.1	<0.001*

LGCP, laparoscopic greater curvature gastric plication; LSG, laparoscopic sleeve gastrectomy.
*Statistically significant as *P value* less than or equal to 0.05.

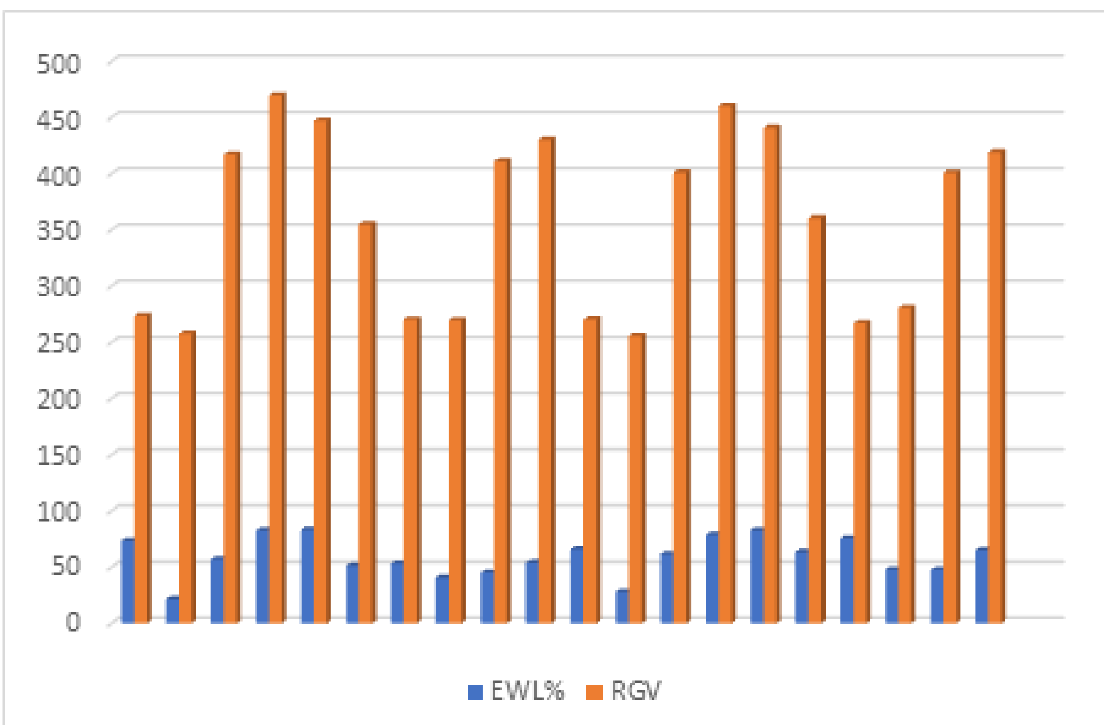

Fig. 3: Correlation between each patients in RGV after 3 months and EWL% after 6 months, in group A. EWL%, excess weight loss percentage; RGV, residual gastric volume.

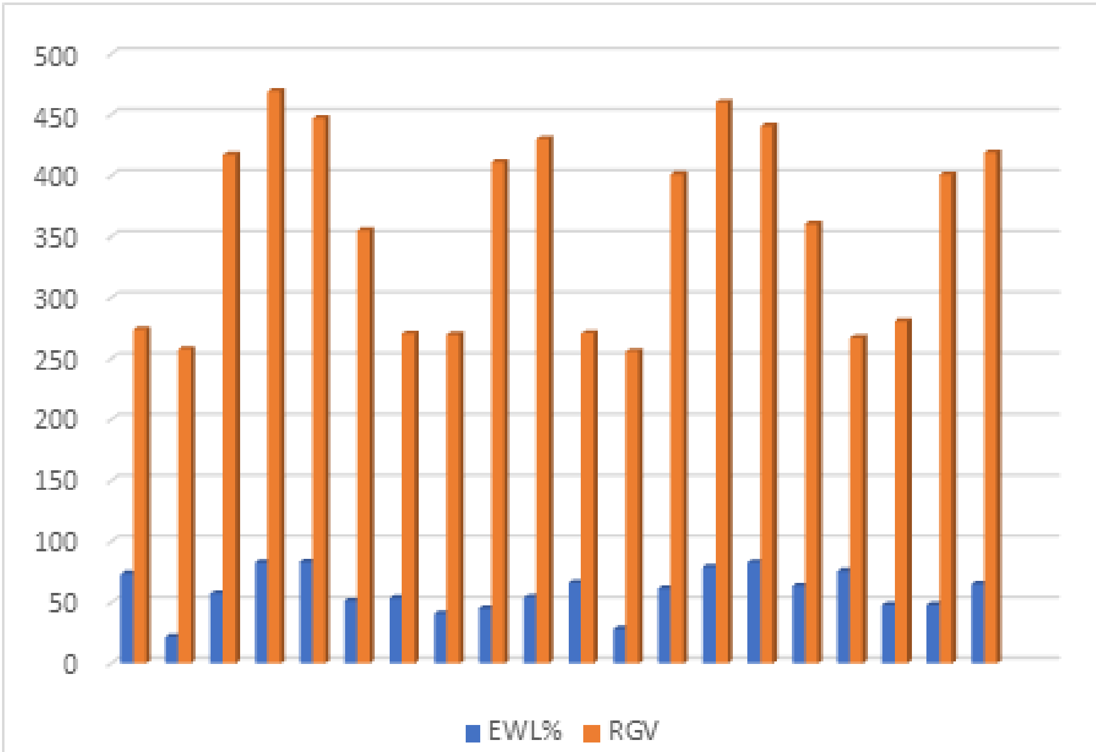

Fig. 4: Correlation between each patient's RGV after 3 months and EWL% after 6 months, in group B. EWL%, excess weight loss percentage; RGV, residual gastric volume.

DISCUSSION

The most effective treatment considered for morbid obesity and obesity-related comorbidities is metabolic bariatric surgery (MBS). Surgical treatment has been demonstrated to produce significantly superior weight loss outcomes compared to medicinal treatment, as well as superior improvement or resolution of obesity-related comorbidities, including hypertension, dyslipidemia, and type 2 diabetes, in numerous clinical trials[11].

Both LSG and LGCP are restrictive bariatric surgeries, with LGCP being relatively new and LGCP being potentially reversible and low cost[12].

Patients must comprehend the probable outcomes of any specific BS in order to make an informed decision regarding whether or not to undergo the operation. The most significant outcome for individuals contemplating MBS surgery is typically weight loss, which is also the most frequently encountered main endpoint for medical practitioners. In order to provide timely intervention for patients with weight regain or insufficient weight loss, healthcare professionals must ascertain whether the patient is on track to achieve their weight loss target at each follow-up visit after the procedure. Patients undergoing MBS require tangible and realistic weight loss goals[3].

In order to anticipate weight loss following LSG, numerous variables were assessed. The calibrating tube's size was one of those variables. When the procedure is executed correctly, the calibrating tube size should be proportional to the RGV and inversely proportional to the resected stomach volume. Few papers evaluated the impact of the resected stomach volume on the weight reduction achieved after the procedure, and the outcomes were controversial. The calibrating tube size did not appear to have an impact on the weight loss achieved by the procedure[13].

Our study was conducted on 40 obese cases assigned into two groups. Group A included 20 females with a mean preoperative BMI of 39 kg/m2 and a mean age of 34 years. This group of patients underwent LGCP.

Elzayat *et al.*[8] conducted a study in Cairo University Hospitals and performed LGCP on 40 females with a BMI 47 kg/m^2 and a mean age of 33.8 years.

Mohamed *et al.*[14] research that was performed at Al Hussein University Hospitals, Egypt in 2019, 30 morbidly obese cases underwent LSG (10 males and 20 females). The BMI was 43.4 kg/m^2, and a mean age was 29.9 years.

In Doğan *et al.*[15] research, 62 patients underwent LSG (12 males and 50 females) with preoperatively BMI of 50.8 kg/m^2 and a mean age of 34 years.

Moursi *et al*.[16] conducted another study that included 30 obese patients (22 females and 8 males). The BMI was 43.3 kg/m^2, and a mean age was 33 years.

In 2017, Bužga *et al*.[17] conducted a study that included 127 patients with morbid obesity, 43 of them underwent LGP (28 females and 15 males), and 84 underwent LSG (61 females and 23 males). The mean preoperative BMI for those who underwent LGP was 42.5 kg/m^2, while for those who underwent LSG was 43.7 kg/m^2. After 6 months the mean EWL% in the LGP group was 42.6%, and that of the LSG group was 55%.

Talebpour *et al*.[18] research, conducted in 2018, included 70 patients, 35 of them underwent LGCP (27 females and eight males), and the rest underwent LSG (29 females and 6 males). The mean age for the LSG group was 38.6 years, and that for the LGCP group was 35.3 years, the mean BMI for the LSG group was 44.6 kg/m^2, and that for the LGCP group was 48.3 kg/m^2. The EWL% 6 months after the surgery was 41.4% regarding LGCP and 49.6% regarding LSG.

We aimed to assess the RGV in both groups and correlate the volume to the EWL%. All the patients in both groups underwent MSCT gastric volumetry after 3 months.

In group A, the RGV was 357 ml, and EWL% postoperatively at 6 months was 59.1%. In group B, the RGV was 132.4 ml, and the EWL% after 6 months was 52.5%.

In Elzayat *et al*.[8] 40 patients underwent MSCT gastric volumetry 1 month after the surgery. The mean RGV was 213 ml, which increased to 355 ml after 12 months. After a year, the average weight loss percentage was 20.9%.

Thirty morbidly obese patients underwent MSCT gastric volumetry 3 months after LSG at Al Hussein University Hospitals during the study conducted by Mohamed *et al*.[14]. The mean RGV after 3 months was 128 ml, while the mean weight reduction percentage was 15% after the same duration.

In Moursi *et al*.[16] study, the cases underwent MSCT gastric volumetry 12 months following LSG, and the mean RGV was 119 ml while weight reduction% was 39%.

Doğan *et al*.[15] assessed the RGV intraoperatively by the instillation of saline into the gastric pouch after LSG, the mean RGV was 97.1. After 6 months, the mean EWL% was 62.6%.

In our study, all cases have been performed by the same operator, with a mean operative time of 67 min in group A and 56 min in group B.

The mean postoperative hospital stay was 2 days in group A and 1 day in group B.

Darabi *et al*.[19] performed LGP for 20 morbidly obese patients; 71 min was the average operating time, while 1.6 days was the average postoperative hospital stay duration.

Albanese *et al*.[20] performed LGCP for a number of 56 obese cases. The average duration of the operation was 72 min.

As for LSG, Vidal *et al*.[21] reported in a research that the mean operative time of LSG that was performed on a number of 114 patients was 93 min, and the mean hospital stay was 3 days.

Trastulli *et al*.[22] stated in a systematic review of randomized trials that 106 min was the average operative time for LSG.

Many studies tried to study the relationship between EWL% and RGV. Deguines *et al*.[7] studied this relationship on 76 patients in Amiens, France, who have undergone LSG. According to the investigation, a high RGV following LSG is a risk factor for failure, and successful postoperative weight loss is related to RGV. Having an understanding of the RGV can be beneficial in the management of failure following LSG.

Another study that was carried out in Alexandria, Egypt, in 2016 on a total of 287 morbidly obese patients reported significantly larger RGVs in men, which hypothesized that these patients had a much bigger total gastric volume, given the RGV was consistent across all cases. Previously, it was demonstrated that postoperative weight reduction was not significantly influenced by minor changes in RGV values[23].

Elzayat *et al*.[8] stated that a weak, nonsignificant positive correlation was observed between the volume of the CT gastric pouch and the weight of the patient at the 1-year follow-up, suggesting that cases with smaller postsurgical gastric volumes had the highest percentage of clinical weight loss.

In prospective research, Braghetto *et al*.[24] compared the stomach capacity of a small sample of just 15 patients as assessed by CT and barium sulfate at 3 days and 24 months postoperatively. The postoperative volume measured with CT and barium sulfate was 116.2±78.2 and 108±25 ml, respectively.

At 2 years, the volume had increased to 254±56.8 and 250±85 ml. Nevertheless, weight reduction was unaffected, and patients maintained a BMI of ~25 and did not experience any regain in lost weight.

In our study, there was a positive relationship between RGV at 3 months and EWL% after 6 months; the less the RGV, the greater the loss of weight in both groups.

The mean RGV in group A was greater than group B (357 ml compared to 132 ml). However, mean EWL% in group A was higher than that in group B (59.1% in group A compared to 52.5% in group B).

This could be explained as follows: in this study, the RGV was measured using MSCT gastric volumetry. In group A, the size of the whole stomach was measured, including the part of the stomach that was invaginated during the plication.

So, the RGV is expected to be much lower if this part of the stomach has not been included in the measurement.

In future studies, we suggest using other methods for more accurate assessment of RGV, like fluoroscopy with contrast swallow, adding virtual gastroscopy to CT volumetry, and combining the radiological methods with esophagogastroscopy or intraoperative saline infusion into the gastric pouch.

Using these techniques separately or combined in future studies could offer a more precise assessment of the RGV.

We expect LGCP to be more and more popular in Egypt during the next few years, being effective in losing weight, safe, low cost, and potentially reversible.

Also, we suggest that further studies that compare long-term outcomes, including EWL%, nutritional deficiencies, and complications in the long-term between LGCP and other MBS be conducted.

In conclusion, it is crucial to emphasize that our investigation is participant to some limitations. In reality, the primary limitation was that the trial was nonrandomized and uncontrolled. Also, small sample size, the short-term follow-up, as well as the absence of some variables (e.g. patients' compliance to postoperative medications and dietary regimens) were also limitations.

CONCLUSION

LGCP and LSG are both effective procedures to treat obesity-related comorbidities and morbid obesity. MSCT gastric volumetry is an effective, easy, safe, and noninvasive tool to assess the RGV after different MBS, especially LSG. RGV might be able to predict the EWL% following LGCP and LSG; the less the RGV, the greater the EWL%, and LGCP is an effective procedure to lose weight despite relatively high RGV.

CONFLICT OF INTEREST

There are no conflicts of interest.

REFERENCES

1. Aboulghate M, Elaghoury A, Elebrashy I, Elkafrawy N, Elshishiney G, Abul-Magd E, Bassiouny E, Toaima D, Elezbawy B, Fasseeh A, Abaza S, Vokó Z. The Burden of Obesity in Egypt. Front Public Health. 2021 Aug 27;9:718978. doi: 10.3389/fpubh.2021.718978. PMID: 34513789; PMCID: PMC8429929.

2. Herouvi D, Paltoglou G, Soldatou A, Kalpia C, Karanasios S, Karavanaki K. Lifestyle and Pharmacological Interventions and Treatment Indications for the Management of Obesity in Children and Adolescents. Children (Basel). 2023 Jul 17;10(7):1230. doi: 10.3390/children10071230. PMID: 37508727; PMCID: PMC10378563.

3. Park JY. Weight Loss Prediction after Metabolic and Bariatric Surgery. J Obes Metab Syndr. 2023 Mar 30;32(1):46-54. doi: 10.7570/jomes23008. Epub 2023 Mar 22. PMID: 36945076; PMCID: PMC10088553.

4. Pucci A, Batterham RL. Mechanisms underlying the weight loss effects of RYGB and SG: similar, yet different. J Endocrinol Invest. 2019 Feb;42(2):117-128. doi: 10.1007/s40618-018-0892-2. Epub 2018 May 5. PMID: 29730732; PMCID: PMC6394763.

5. Tsao LC, Lin J, Wang BY, Chang YJ, Huang CY, Yu SF, Hung WY, Lin CC, Chan CP. Long-Term Outcomes of Laparoscopic Greater Curvature Plication and Laparoscopic Sleeve Gastrectomy: Critical Appraisal of the Role of Gastric Plication in Bariatric Surgery. Medicina (Kaunas). 2022 Sep 17;58(9):1299. doi: 10.3390/medicina58091299. PMID: 36143976; PMCID: PMC9503388.

6. Bjørklund G, Semenova Y, Pivina L, Costea DO. Follow-up after bariatric surgery: A review. Nutrition. 2020 Oct;78:110831. doi: 10.1016/j.nut.2020.110831. Epub 2020 Apr 21. PMID: 32544850.

7. Deguines JB, Verhaeghe P, Yzet T, Robert B, Cosse C, Regimbeau JM. Is the residual gastric volume after laparoscopic sleeve gastrectomy an objective criterion for adapting the treatment strategy after failure? Surg Obes Relat Dis. 2013 Sep-Oct;9(5):660-6. doi: 10.1016/j.soard.2012.11.010. Epub 2013 Jan 17. PMID: 23452922.

8. Elzayat W, El-Kalioubie M, Elshafie M, Hassan A. Role-of-ct-volumetry-following-gastricplication-surgery-in-morbid-obesity initial-experience-in-correlating post-operative. Imaging Med. 2017;9:89-94.

9. Refaat M, Elshazly I, Mansour A. Estimation of Gastric Volume after Laparoscopic Sleeve Gastrectomy by Multidetector Computed Tomography and Correlation with Weight Reduction. Benha Med J. 2020;37:32-42.

10. Chen HY, Yang PJ, Lee PC, Chuang PH, Yang YH, Chiu WT, *et al*. Computed tomography-based gastric volumetry for morbid obesity to assess weight loss and fatty liver change. J Formos Med Assoc. 2024.

11. Kirwan JP, Courcoulas AP, Cummings DE, Goldfine AB, Kashyap SR, Simonson DC, *et al*. Diabetes Remission in the Alliance of Randomized Trials of Medicine Versus Metabolic Surgery in Type 2 Diabetes (ARMMS-T2D). Diabetes Care. 2022;45:1574-83.

12. Verdi D, Prevedello L, Albanese A, Lobba A, Foletto M. Laparoscopic Gastric Plication (LGCP) Vs Sleeve Gastrectomy (LSG): A Single Institution Experience. Obes Surg. 2015;25:1653-7.

13. Baraki YM, Traverso P, Elariny HA, Fang Y. Preoperative prediction of stomach weight to be removed in laparoscopic sleeve gastrectomy procedure. Surg Technol Int. 2010;20:167-71.

14. Mohamed AENY, Elfeshawy MS, Sokker EAA. Role of CT Gastric Volumetric Study in Sleeve Gastrectomy. EJHM. 2019;76:3724-35.

15. Doğan S, Önmez A, Çetin MF, Özaydın İ, Pehlivan M. Residual Gastric Volume Relationship and Weight Loss After Laparoscopic Sleeve Gastrectomy. Obes Surg. 2020;30:1929-34.

16. Moursi DMA-E, Allam KE, Hetta W, Elsalam AMA, Hussein RS. Role of 3D-CT gastric volumetric study in post-sleeve gastrectomy. Egypt J Radiol Nucl Med. 2022;53:144.

17. Bužga M, Švagera Z, Tomášková H, Hauptman K, Holéczy P. Metabolic Effects of Sleeve Gastrectomy and Laparoscopic Greater Curvature Plication: an 18-Month Prospective, Observational, Open-Label Study. Obes Surg. 2017;27:3258-66.

18. Talebpour M, Sadid D, Talebpour A, Sharifi A, Davari FV. Comparison of Short-Term Effectiveness and Postoperative Complications: Laparoscopic Gastric Plication vs Laparoscopic Sleeve Gastrectomy. Obes Surg. 2018;28:996-1001.

19. Darabi S, Talebpour M, Zeinoddini A, Heidari R. Laparoscopic gastric plication versus mini-gastric bypass surgery in the treatment of morbid obesity: a randomized clinical trial. Surg Obes Relat Dis. 2013;9:914-9.

20. Albanese A, Prevedello L, Verdi D, Nitti D, Vettor R, Foletto M. Laparoscopic Gastric Plication: An Emerging Bariatric Procedure with High Surgical Revision Rate. Bariatr Surg Pract Patient Care. 2015;10:93-8.

21. Vidal P, Ramón JM, Goday A, Benaiges D, Trillo L, Parri A, *et al*. Laparoscopic gastric bypass versus laparoscopic sleeve gastrectomy as a definitive surgical procedure for morbid obesity. Mid-term results. Obes Surg. 2013;23:292-9.

22. Trastulli S, Desiderio J, Guarino S, Cirocchi R, Scalercio V, Noya G, *et al*. Laparoscopic sleeve gastrectomy compared with other bariatric surgical procedures: a systematic review of randomized trials. Surg Obes Relat Dis. 2013;9:816-29.

23. Bekheit M, Abdel-Baki TN, Gamal M, Abdel-Salam W, Samir M, ElKayal E, *et al*. Influence of the Resected Gastric Volume on the Weight Loss After Laparoscopic Sleeve Gastrectomy. Obes Surg. 2016;26:1505-10.

24. Braghetto I, Cortes C, Herquiñigo D, Csendes P, Rojas A, Mushle M, *et al*. Evaluation of the radiological gastric capacity and evolution of the BMI 2-3 years after sleeve gastrectomy. Obes Surg. 2009;19:1262-9.