RELATIONSHIP BETWEEN RESIDUAL GASTRIC AREA AND WEIGHT LOSS AFTER SLEEVE GASTRECTOMY: A COHORT STUDY

RUNNING HEADS: Imaging after laparoscopic sleeve gastrectomy

ABSTRACT

BACKGROUND: The aim of this study is to evaluate the impact of the actual size and area of the remnant stomach, as measured by Upper gastrointestinal tract radiography, on weight loss after sleeve gastrectomy.

MATERIALS AND METHODS: From May 2017 to December 2019, 56 patients with morbid obesity were admitted to the Department of Medical and Surgical Sciences, University of Foggia and underwent laparoscopic sleeve gastrectomy.

RESULTS: 56 patients underwent sleeve gastrectomy with a mean age of 43,5 ± 11 years of which 40 were female. The mean Excess Weight Loss (EWL) at 1 month was 24,09 ± 15,04 %, at 6 months was 27,07 ± 19,55 % and at 12 months was 69,9 ± 23,7 %. The mean Excess Body Mass Index Loss (EBMIL) at 1 month was 23,1 ± 12,5%, at 6 months was 56,6 ± 19,7% and at 12 months was 69,7 ± 23,7 %.

The EWL % was correlated with the residual stomach area (RSA) at 1 month (r=-0,242 p=0,072), at 6 months (r=-0,249 p=0,064) and at 12 months (r=-0,451 p= 0,0005).

The EBMIL % was correlated with the RSA at 1 month (r = -0,270; p = 0,043), at 6 months (r = -0,270; p = 0,043) and at 12 months (r = -0,46; p = 0,0004).

CONCLUSION: A greater postoperative EWL % was correlated with a smaller RSA and this resulted in a statistically significant change at 12 months after surgery.

Key words: laparoscopic sleeve gastrectomy, EWL, UGI radiography

INTRODUCTION

Obesity is a rising global epidemic that places significant strain on healthcare services worldwide. Morbid obesity is associated to complications affecting nearly every organ , resulting in a decrease in life expectancy [1-3].

In the last few years, various international guidelines and systematic reviews have confirmed laparoscopic sleeve gastrectomy (LSG) as a definitive and stand-alone procedure for morbid obesity [4-7].

LSG is perceived as one of the safest bariatric operations. The main advantages of LSG include: a relatively simple surgical technique with no need of anastomosis creation, short learning curve and low rate of metabolic complications [8].

Within bariatric surgery, it is common that radiologists must deal with the interpretation of images of patients after LSG. There are differences in peri and postoperative care protocols and likewise with the approach to the imaging algorithm.

Upper Gastrointestinal (UGI) tract radiography with water-soluble contrast medium is the most basic study after LSG. This minimally invasive technique has a long history of being used for the detection of both early and late postoperative complications [9, 10].

A normal postoperative UGI series will show free flow of contrast into the gastric remnant, which is tubular with no spillage of contrast beyond the staple line, which is located on the caudal aspect of the gastric remnant. Stenosis or obstruction of the stomach may occur if the stomach remnant is too tight or with torsion of the stomach[11].

In the literature most of the authors studied the correlation between postoperative gastric volume and percent excess weight loss (EWL) [12, 13]. The size of the remnant stomach with respect to weight loss after LSG remains controversial.

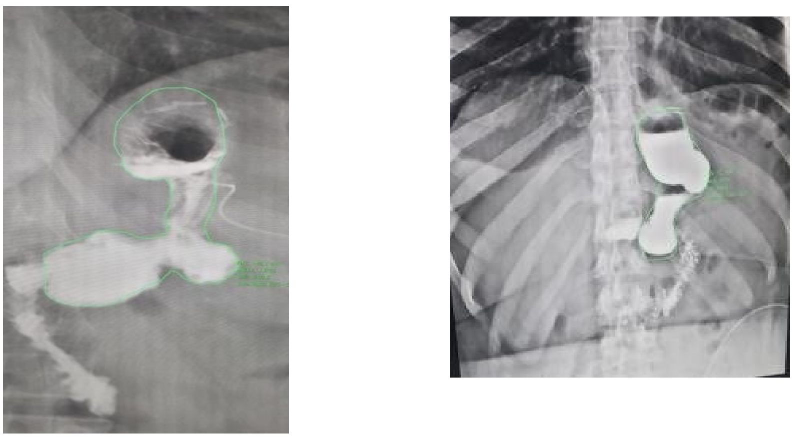
The aim of this study is to evaluate the impact of the actual size and area of the remnant stomach, as measured by Upper gastrointestinal tract radiography, on weight loss after LSG.

MATERIALS AND METHODS

Study design and setting

From May 2017 to December 2019, 56 patients with morbid obesity were admitted to the Department of Medical and Surgical Sciences, University of Foggia and underwent laparoscopic sleeve gastrectomy. UGI tract radiography with water-soluble contrast medium was performed on the second day after the operation to rule out leakage. The radiographic images were collected through a software program called "PACS" which combined with a viewer for image processing, allows for the calculation of the residual stomach area (RSA). RSA was correlated with postoperative weight (EWL) at 1, 6, and 12 months (Figure 1). The UIN for ClinicalTrial.gov Protocol Registration and Results System is:1 for the Organization UFoggia.

Figure 1: UGI tract radiography collected through a software called "PACS"



Eligibility criteria

Adult patients of both genders with morbid obesity defined as BMI>40 kg/m^2 or BMI>35 kg/m^2 with at least one associated major comorbidity were included. We excluded patients with secondary obesity due to endocrine and psychological disorders, patients with previous bariatric procedures and patients unwilling to comply with postoperative diet and exercise program.

Statistical analysis

Continuous data were expressed as mean and standard deviation (SD) and they were analyzed using Student's T test. The correlation between gastric volume before and after LSG and BMI and weight loss was measured using Pearson correlation coefficient test. Correlation coefficients were classified as strong (-1.0 to -0.5 or 0.5 to 1.0), moderate (-0.5 to -0.3 or 0.3 to 0.5), and weak (-0.3 to -0.1 or 0.1 to 0.3). P<0.05 was considered statistically significant. This work is fully compliant with the STROCSS criteria [14].

RESULTS

56 patients underwent sleeve gastrectomy with a mean age of 43,5± 11 years of which 40 were female. The mean preoperative weight was 127,5 ± 19,8 kg and the preoperative mean Body Mass Index (BMI) was 45,5± 5,57 kg/m^2. The mean residual stomach area (RSA) was 64,8 ± 16,5 cm^2(Table 1).

Table 1: Demographic and operative characteristics of the study groups

Age (years) mean ± (SD)	43,5 ± 11
Sex: n male / female	16/40
Height (cm)mean±(SD)	167 ± 9,3
Preoperative weight (Kg) mean±(SD)	127,5 ± 19,8
Preoperative BMI (kg/m^2) mean ±(SD)	45,5 ± 5,57
Residual Stomach Area (cm^2) mean±(SD)	64,8 ± 16,5

SD: Standard Deviation

The mean Excess Weight Loss (EWL) at 1 month was 24,09 ± 15,04 %, at 6 moths was 27,07 ± 19,55 %, at 12 months was 69,9 ± 23,7 %. The mean Excess Body Mass Index Loss (EBMIL) at 1 month was 23,1 ± 12,5 %, at 6 months was 56,6 ± 19,7 %, at 12 months was 69,7 ± 23,7 % (Table 2).

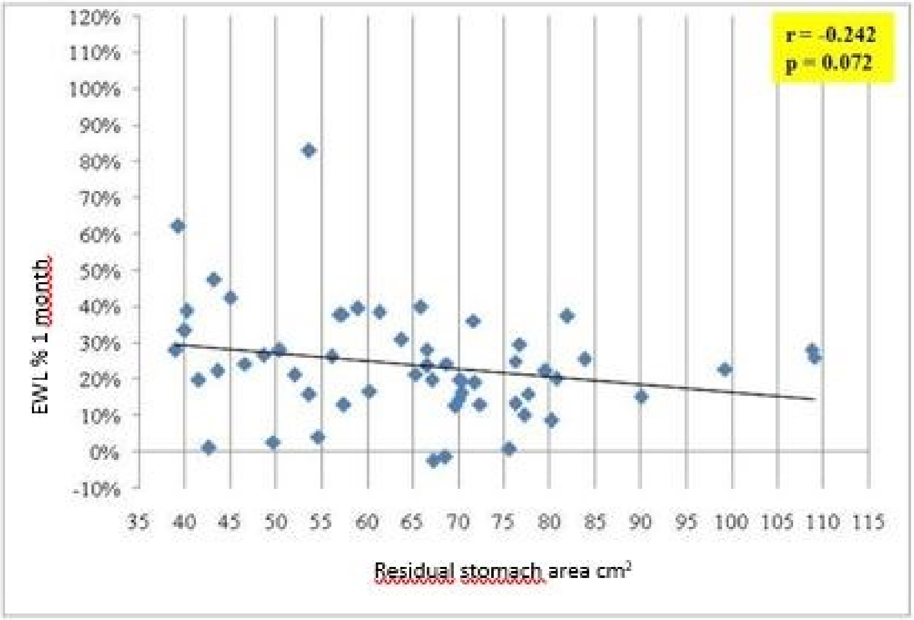
Table 2: % EWL mean - % EBMIL mean

% EWL mean - % EBMIL mean	
% EWL 1 month (mean) ±(SD)	24,09 ± 15,04
% EWL 6 months (mean) ±(SD)	27,07 ± 19,55
% EWL 12 months (mean) ±(SD)	69,9 ± 23,7
% EBMIL 1 month (mean) ±(SD)	23,1 ± 12,5
% EBMIL 6 months (mean) ±(SD)	56,6 ±19,7
% EBMIL 12 months (mean) ±(SD)	69,7 ± 23,7

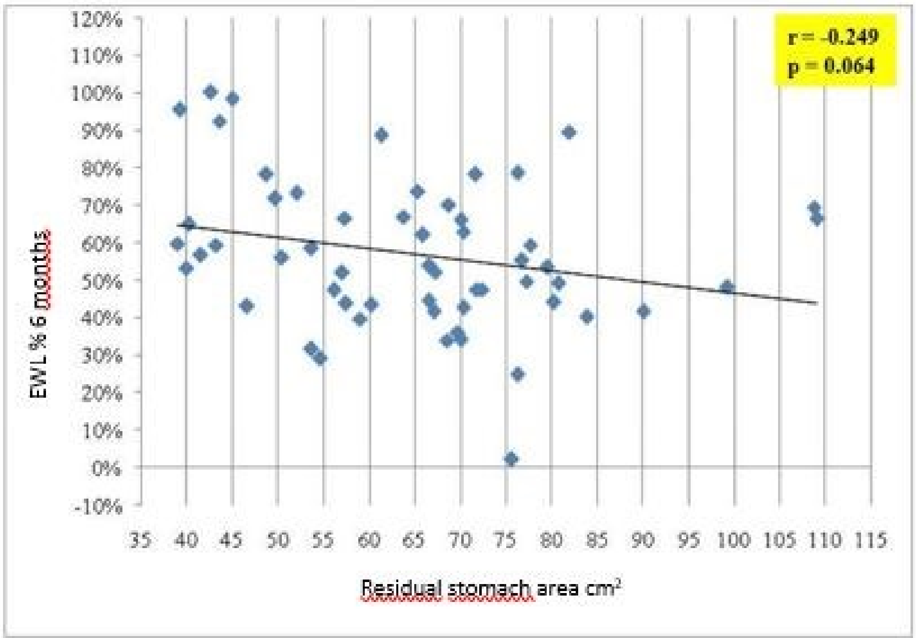
SD: Standard Deviation EWL: Excess Weight Loss EBMIL: Excess Body Mass Index Loss

The EWL % was correlated with the RSA at 1 month (r=-0,242 p=0,072), at 6 months (r = -0,249 p = 0,064) and at 12 months (r = -0,451 p = 0,0005) (Graphic 1, 2, 3).

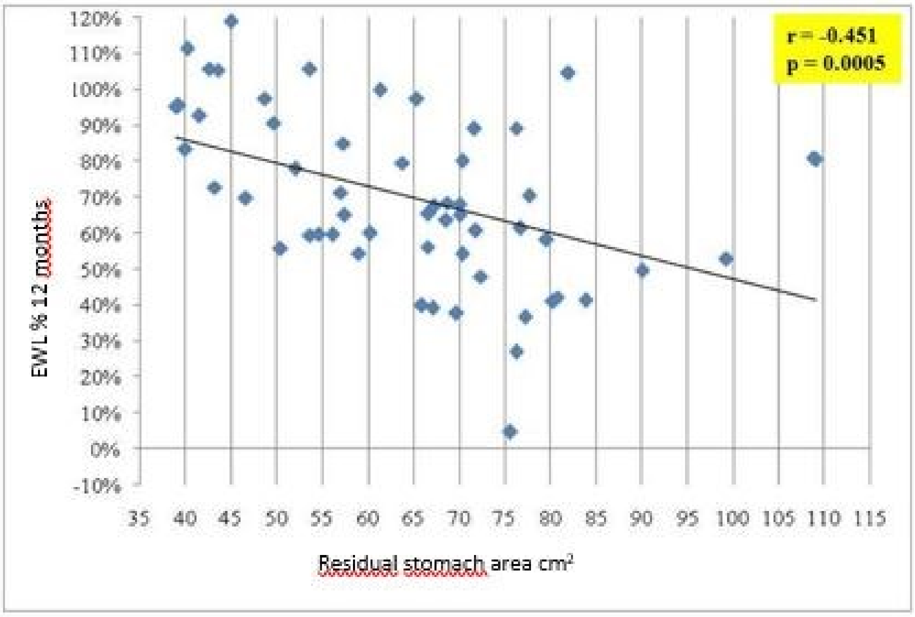
Graphic 1 : % EWL 1 month – Pearson correlation – p value



Graphic 2 : % EWL 6 months – Pearson correlation – p value

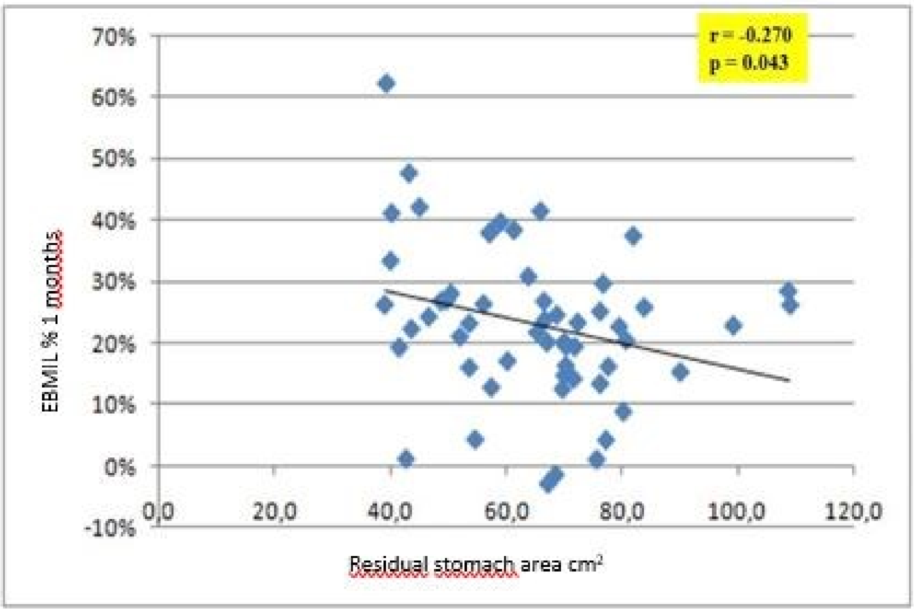


Graphic 3 : % EWL 12 months – Pearson correlation – p value

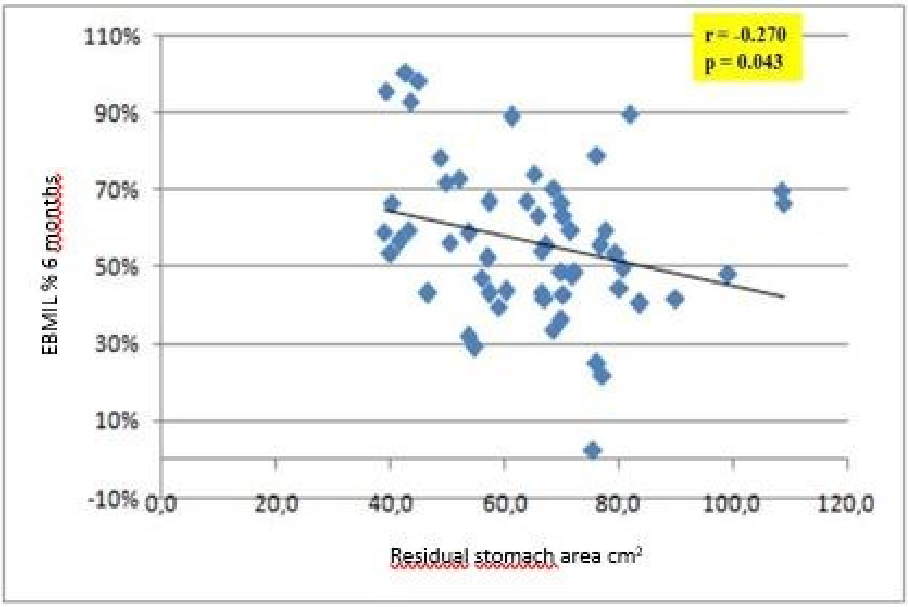


The EBMIL % was correlated with the RSA at 1 month (r = -0,270; p =0,043), at 6 months (r = -0,270; p = 0,043) and at 12 months (r = -0,46; p = 0,0004) (Graphic 4, 5, 6).

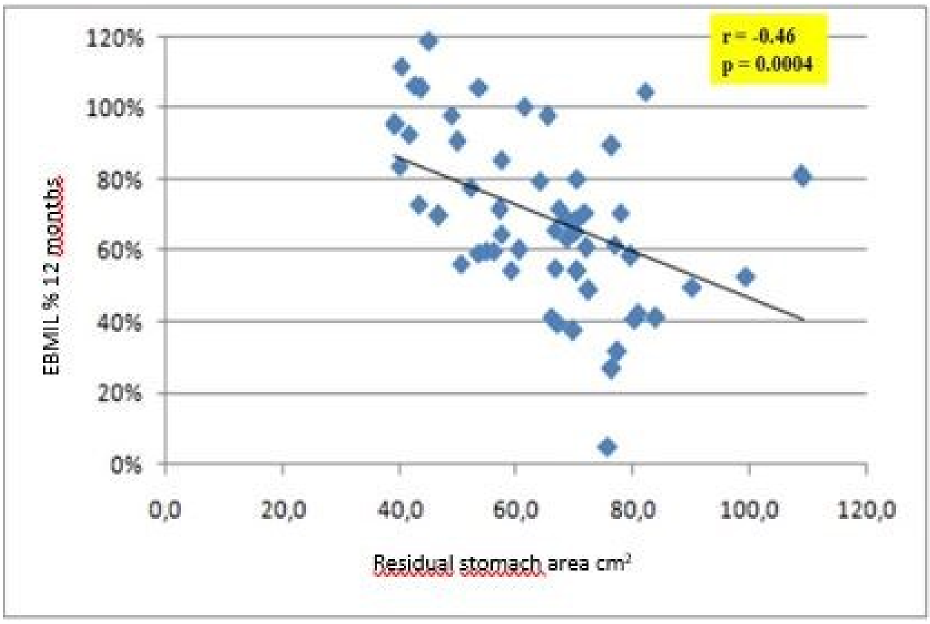
Graphic 4: % EBMIL 1 month – Pearson correlation – p value



Graphic 5: % EBMIL 6 months – Pearson correlation – p value



Graphic 6: % EBMIL 12 months – Pearson correlation – p value



DISCUSSION

LSG has become a popular technique in the treatment of morbid obesity owing to the satisfactory outcome as recently demonstrated in the SM-BOSS randomized trial which concluded that LSG and Roux-Y-gastric bypass are equally effective regarding short and mid-term weight loss, improvement in comorbidities, and complications [15]. Nevertheless, LSG can still be associated with failure to achieve significant EWL or failure to sustain weight loss with eventual weight regain at long-term follow-up [16].

LSG is a volume-restrictive procedure, the volume of remaining gastric pouch after LSG and the volume of the resected stomach were studied as possible causes of inappropriate weight loss or weight regain after the procedure [17–21] (Figure 2).

Figure 2: Excised stomach

Elbanna et al. used CT volumetry for measuring the gastric volume before and immediately after LSG to assess the correlation of gastric volumes pre- and postoperatively and weight loss at 6 months after the procedure. They concluded that the size of the remaining gastric pouch and the percentage of the resected stomach had significant impact on % EWL after LSG [22].

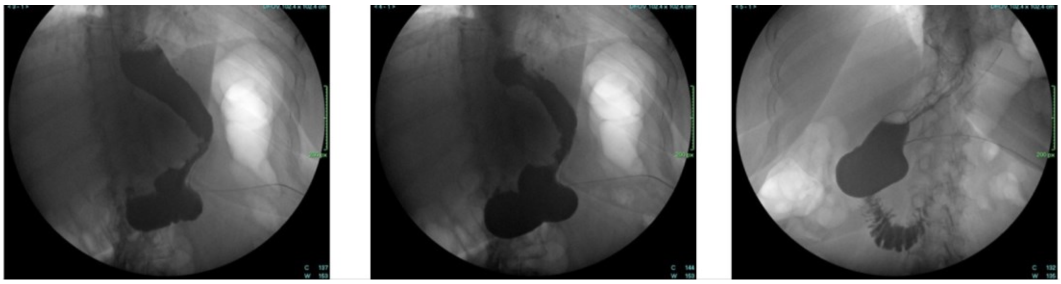
Salman MAA et al. used multidetector computed tomography (MDCT) to measure preoperative stomach volume and cuff volume. The actual resected gastric volume was measured after surgery. The primary outcome was the relationship between residual gastric volume and percentage of excess body weight loss (% EBWL) after 3 and 6 months. The secondary outcome was early postoperative complications. They concluded that gastric volume removed 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 of measuring gastric volume before and after surgery [23].

Hanssen et al. analyzed thirty patients who underwent LSG and were followed prospectively and evaluated at 6 months after the surgical procedure, performing 3D CT reconstruction and gastric volumetry, to establish its relationship with EWL. A significant relationship between gastric volume (GV) and EWL 6 months after LSG was established, demonstrating that GV ≥ 100 ml at 6 months of LSG is associated with poor EWL [24].

In recent years, CT has been increasingly used as a primary postoperative examination after bariatric procedures for the detection of complications. There are many studies in the literature that analyze the potential relationship of residual gastric volume with excess weight loss in patients with sleeve gastrectomy. The main concern associated with the use of CT is its high radiation dose.

The advantages of UGI radiography compared to CT include the speed of the procedure, the reduced associated costs, shorter waiting times for the patient and lower dose of radiation to which the patient is exposed. There is a significant difference in terms of absorption of radiation between the 3DCT and the direct abdomen, 7.8mSV vs 1mSV (Figure3).

Figure3: UGI tract after LSG



The present study has some limitations that include a small sample size, the single-center nature of the study and the short follow-up duration.

CONCLUSION

A greater postoperative EWL % was correlated with a smaller RSA and this is statistically significant at 12 months after surgery ($p<0,05$). Although in the literature the standard for the relationship with post LSG weight loss is a volumetric measurement through 3DCT, the study of the RSA by UGI radiography could provide an important alternative, with an advantage demonstrated in terms of reduction of radiation absorbed by the patient, speed of procedure and reduction of costs to the NHS. Larger studies over a longer period of time are needed to confirm these findings.

REFERENCES

1. Vidal P, Ramón JM, Busto M, et al. Residual gastric volume esti- mated with a new radiological volumetric model: relationship with weight loss after laparoscopic sleeve gastrectomy. Obes Surg. 2014;24(3):359–63.
2. Hess DS, Hess DW. Biliopancreatic diversion with a duodenal switch. Obes Surg. 1998;8(3):267–82.
3. Marceau P, Hould FS, Simard S, et al. Biliopancreatic diversion with duodenal switch. World J Surg. 1998;22(9):947–54.
4. Brethauer SA, Hammel JP, Schauer PR (2009) Systematic review of sleeve gastrectomy as staging and primary bariatric procedure. Surg Obes Relat Dis. 5:469–475
5. Deitel M, Gagner M, Erickson AL, Crosby RD (2011) Third International Summit: current status of sleeve gastrectomy. Surg Obes Relat Dis. 7:749–759
6. Rosenthal RJ, International Sleeve Gastrectomy Expert Panel, Diaz AA, Arvidsson D, Baker RS, Basso N, Bellanger D, Boza C, El Mourad H, France M, Gagner M, Galvao-Neto M, Higa KD, Himpens J, Hutchinson CM, Jacobs M, Jorgensen JO, Jossart G, Lakdawala M, Nguyen NT, Nocca D, Prager G, Pomp A, Ramos AC, Rosenthal RJ, Shah S, Vix M, Wittgrove A, Zundel N (2012) International Sleeve Gastrectomy Expert Panel Consensus Statement: best practice guidelines based on experience of [12,000 cases. Surg Obes Relat Dis. 8:8–19
7. Chopra A, Chao E, Etkin Y, Merklinger L, Lieb J, Delany H (2012) Laparoscopic sleeve gastrectomy for obesity: can it be considered a definitive procedure? Surg Endosc 26:831–837

8. Trastulli S, Desiderio J, Guarino S, et al. Laparoscopic sleeve gastrectomy compared with other bariatric surgical procedures: a systematic review of randomized trials. Surg Obes Relat Dis 2013; 9: 816829.
9. Ekinci T, Stein MW, Mazzariol FS, et al. Laparoscopic sleeve gastrec tomy: everything the radiologist needs to know. Clin Imaging 2017; 43: 3641.
10. Lazoura O, Zacharoulis D, Triantafyllidis G, et al. Symptoms of gastro esophageal reflux following laparoscopic sleeve gastrectomy are related to the final shape of the sleeve as depicted by radiology. Obes Surg 2011; 21: 295299.
11. Barnard SA, Rahman H, Foliaki A. The postoperative radiological features of laparoscopic sleeve gastrectomy. J Med Imaging Radiat Oncol. 2012 Aug;56(4):425-31. doi: 10.1111/j.1754-9485.2012.02401.x. Epub 2012 Jul 2. PMID: 22883650.
12. Hanssen A, Plotnikov S, Acosta G, Nun˜ez JT, Haddad J, Rodri- guez C et al (2017) 3D volumetry and its correlation between postoperative gastric volume and excess weight loss after sleeve gastrectomy. Obes Surg. https://doi.org/10.1007/s11695-017- 2927-8
13. Yamaguchi T, Yamamoto H, Tomozawa Y, Ugi S, Kaida S, Miyake T, Morino K, Watanabe Y, Maegawa H, Tani M. Geometry of Sleeve Gastrectomy Measured by 3D CT Versus Weight Loss: Preliminary Analysis. World J Surg. 2021 Jan;45(1):235-242. doi: 10.1007/s00268-020-05807-5. Epub 2020 Oct 9. PMID: 33037439.
14. Agha R, Abdall-Razak A, Crossley E, Dowlut N, Iosifidis C and Mathew G, for the STROCSS Group. The STROCSS 2019 Guideline: Strengthening the Reporting of Cohort Studies in Surgery. International Journal of Surgery 2019;72:156-165.
15. Peterli R, Wo¨lnerhanssen BK, Vetter D, Nett P, Gass M, Borbe´ly Y et al (2017) Laparoscopic sleeve gastrectomy versus Roux-Y- gastric bypass for morbid obesity-3-year outcomes of the prospective randomized Swiss Multicenter Bypass or Sleeve Study (SM-BOSS). Ann Surg 265(3):466–473. https://doi.org/10.1097/SLA.0000000000001929

16. Himpens J, Dobbeleir J, Peeters G (2010) Long-term results of laparoscopic sleeve gastrectomy for obesity. Ann Surg 252(2):319–324
17. Golomb I, Ben David M, Glass A et al (2015) Long-term meta- bolic effects of laparoscopic sleeve gastrectomy. JAMA Surg 150(11):1051–1057
18. Braghetto I, Korn O, Valladares H et al (2007) Laparoscopic sleeve gastrectomy: surgical technique, indications and clinical results. Obes Surg 17(11):1442–1450
19. Nocca D, Krawczykowsky D, Bomans B et al (2008) A prospective multicenter study of 163 sleeve gastrectomies: results at 1 and 2 years. Obes Surg 18(5):560–565
20. Weiner RA, Weiner S, Pomhoff I et al (2007) Laparoscopic sleeve gastrectomy—influence of sleeve size and resected gastric volume. Obes Surg 17(10):1297–1305
21. Hanssen A, Plotnikov S, Acosta G, Nun˜ez JT, Haddad J, Rodri- guez C et al (2017) 3D volumetry and its correlation between postoperative gastric volume and excess weight loss after sleeve gastrectomy. Obes Surg. https://doi.org/10.1007/s11695-017- 2927-8
22. Elbanna H, Emile S, El-Hawary GE, Abdelsalam N, Zaytoun HA, Elkaffas H, Ghanem A. Assessment of the Correlation Between Preoperative and Immediate Postoperative Gastric Volume and Weight Loss After Sleeve Gastrectomy Using Computed Tomography Volumetry. World J Surg. 2019 Jan;43(1):199-206. doi: 10.1007/s00268-018-4749-9. PMID: 30094637.
23. Mohammed Abd Allah Salman, Mostafa Elshazly, Amr Ali Ragab, Tarek Osama Hegazy. Relationship between the resected stomach volume and early postoperative weight loss following laparoscopic sleeve gastrectomy. *Int Surg J. 2018 Apr;5(4):1180-1185*
24. Hanssen A, Plotnikov S, Acosta G, Nuñez JT, Haddad J, Rodriguez C, Petrucci C, Hanssen D, Hanssen R. 3D Volumetry and its Correlation Between Postoperative Gastric Volume and Excess Weight Loss After Sleeve Gastrectomy. Obes Surg. 2018 Mar;28(3):775-780. doi: 10.1007/s11695-017-2927-8. PMID: 28914408.

Provenance and peer review

Not commissioned, externally peer-reviewed