Nuclear Medicine Communications

Technical note

Comparative assessment of gastric emptying in obese patients before and after laparoscopic sleeve gastrectomy using radionuclide scintigraphy

Ahmed A. Kandeel[a], Mohamed D. Sarhan[b], Tarek Hegazy[b], Moustafa M. Mahmoud[b] and Mohamed H. Ali[b]

Radionuclide scintigraphy provides a standard physiologic evaluation of gastric emptying (GE) after laparoscopic sleeve gastrectomy (LSG). This operation can be associated with motor gastric dysfunction and abnormal GE. The aim of this study was to evaluate the short-term effect of LSG on GE quantitative indices for liquids and solids compared with preoperative results. Forty obese patients were divided into two equal groups, the liquid and solid groups. ^{99m}Tc–sulfur colloid GE scintigraphy was performed on all patients submitted to LSG before and after surgery (1–4 weeks for liquids and 4–6 weeks for solids). The quantitative indices included half emptying time (*T*1/2) and percentage gastric retention at 15, 30, and 60 min for liquids and at 30, 60, 90, and 120 min for solids. A modified technique was used to label a boiled egg in order to be tolerated by the patients. *T*1/2 was significantly enhanced after LSG compared with baseline (25.3 ± 4.4 vs. 11.8 ± 3.0 min for liquids and 74.9 ± 7.1 vs. 28.4 ± 8.3 min for solids, respectively, $P<0.001$). The percentage of gastric retention in operated patients was significantly less than that at baseline for liquids at 15, 30, and 60 min (33.9 ± 5.6, 17.7 ± 3.9, and 7.5 ± 2.8% vs. 69.4 ± 10.5, 55.6 ± 14.95, and 26.1 ± 4.7%, respectively, $P<0.001$), as well as for solids at 30, 60, 90, and 120 min (42.0 ± 11.1, 20.8 ± 6.1, 11.0 ± 5.9, and 3.8 ± 2.7% vs. 79.9 ± 8.7, 67.4 ± 12.2, 37.0 ± 10.9%, and 13.8 ± 4.4%, respectively, $P<0.001$). The significant acceleration of GE of liquids and solids after LSG may have contributed to weight loss in the immediate postoperative period (4–6 weeks). It remains to be determined whether the weight loss will continue beyond that period. *Nucl Med Commun* 00:000–000

Nuclear Medicine Communications 2015, **00**:000–000

Keywords: gastric emptying, laparoscopic sleeve gastrectomy, obesity, radionuclide scintigraphy

Departments of [a]Nuclear Medicine and [b]General Surgery, Kasr Al-Einy Hospital, Cairo University, Cairo, Egypt

Correspondence to Ahmed A. Kandeel, MD, No.1424, 4th District, 7th Neighborhood, 6 October City, Giza 12573, Egypt
e-mail: ahmedkandeel@yahoo.com
tel: 002 02 38336673 fax: 002 02 23635554 AQ2

Received 4 January 2015 **Revised** 4 April 2015 **Accepted** 5 April 2015

Introduction

Worldwide, the prevalence of obesity and obesity-related diseases is inclining to an alarming figure, and a lot of research is underway to understand and control this pandemic. Bariatric procedures are involved in the management of morbidly obese patients, especially if associated with metabolic diseases.

Laparoscopic sleeve gastrectomy (LSG) has become a very frequent procedure in bariatric surgery because of its simplicity and efficacy compared with the gastric bypass procedure. It has succeeded in becoming the sole procedure for the management of morbid obesity and its associated metabolic diseases [1].

This operation comprises major gastric resection, which could be associated with motor gastric dysfunction because of the resection of a gastric pacemaker, resulting in multiple neurohormonal changes [2].

AQ3 Radionuclide studies on gastric emptying and motility are the most common physiologic studies available for studying gastric motor function. The study is noninvasive, uses a physiologic meal (solids or liquids), and is quantitative [3].

Although gastric-emptying scintigraphy has been considered the standard for measuring gastric emptying, there is a lack of standardization of the test, including differences in the meals used, in patient positioning, and in the frequency and duration of imaging. There are differences in the quantitative data reported – for example, half-time of emptying, rate of emptying (percentage per minute), and the percentage retention or emptying at different time points during the study [3,4]. Normal values have often not been established for some of the protocols used, and the performance characteristics of the test with the specified meal may not have been established or published [5].

The aim of this study was to evaluate the short-term effect of LSG on quantitative indices of gastric emptying for liquids and solids in obese patients compared with preoperative results.

Patients and methods

Patients

Forty obese patients were investigated prospectively in this study (seven male and 33 female patients; mean age 31.6 ± 8.1 years). The patients were divided into two

DOI: 10.1097/MNM.0000000000000337

equal groups. The liquid group included 20 patients (three male and 17 female patients, mean age 30.7 ± 8.0 years, mean BMI 48.7 ± 3.3 kg/m^2) who were evaluated for liquid gastric emptying scintigraphy before and 1–3 weeks after LSG. The solid group included 20 patients (four male and 16 female patients, mean age 32.5 ± 8.1 years, mean BMI 49.1 ± 7.1 kg/m^2) who were evaluated for solid gastric emptying before and 4–6 weeks after LSG. Preoperative workup included blood tests, chest radiography, pulmonary function tests, electrocardiography, abdominal ultrasonography, and endocrinological profiling of thyroid and adrenal function. The protocol of the study was approved by the ethics committee of the university hospital and informed consent was obtained from all patients.

Operative technique

Under general anesthesia, the patient was placed in a modified lithotomy position (Lloyd–Davies) after elastic compression stockings had been put on the lower legs. Both arms were padded and tucked at the patient's side. After establishing the pneumoperitoneum using either the veress needle in the left hypochondrium or the open Hasson method, the first trocar for the optical port was placed in the periumbilical region slightly above and to the left of the umbilicus according to the patient's body proportion, using a 10 mm port. Thirty-degree optics were used. Two 12 mm ports were placed in both the right and the left hypochondrium in the midclavicular line as the surgeon's working hands. According to the liver size, another 5 or 10 mm port was added in the epigastrium as a liver retractor. A fifth 5 mm port was added in the left anterior axillary line for an extra second
AQ4 assistance. First, the greater omentum attached to the greater curvature was taken down medially to the gastroepiploic arch using ultrasonic shears, reaching 3–4 cm proximal to the pyloric ring downward and upward, opening the angle of His, exposing the left crus to free the fundal bare area and control the posterior gastric artery if encountered and opening the gastrophrenic ligament. A 36 Fr bougie was orally advanced into the stomach and the pylorus along the lesser curvature of the stomach, until it reached the first part of the duodenum. Then, a reticulating linear stapler was used to create the gastric sleeve around the bougie. The first stapling car-
AQ5 tridge was green (4.1 mm) for the thicker tissue at the antrum, followed by gold (3.8 mm) and then blue cartridges (3.5 mm) until the angle of His was reached. A methylene blue test was applied after stapling to check the integrity of the staple line. One drain was inserted away from the staple line for fear of reactionary hemorrhage or leaks.

A routine gastrografine swallow radiology test was performed for all patients 24–48 h postoperatively to assess leakage (Fig. 1).

Gastric-emptying study

Radiopharmaceutical and image acquisition

Patients had to fast for at least 8 h before the study. At the time of the study, none of the patients had diabetes or were under medications known to affect gastric motility (such as metoclopramide, opiates, or antispasmodic agents).

Imaging was performed with the patient in the supine position using a dual-head gamma camera equipped with an all-purpose, low-energy, parallel-hole collimator covering an NaI (Tl) crystal of 3/8 inch thickness, set at 140 keV, with a 20% window, zoom 1.0, using a matrix size of 64 × 64 for dynamic acquisition and 128 × 128 for static acquisition at different time intervals. In the solid study, patients were allowed to be in the sitting position between each measurement.

Liquid meal

^{99m}Tc–sulfur colloid (37 MBq, 1 mCi) was added to 200 ml water at baseline, and the volume was reduced to 100 ml water after LSG. Anterior and posterior dynamic images including the distal esophagus, stomach, and proximal small bowel in the field of view were taken immediately after drinking the solution, for 60 min (1 frame/min).

Solid meal

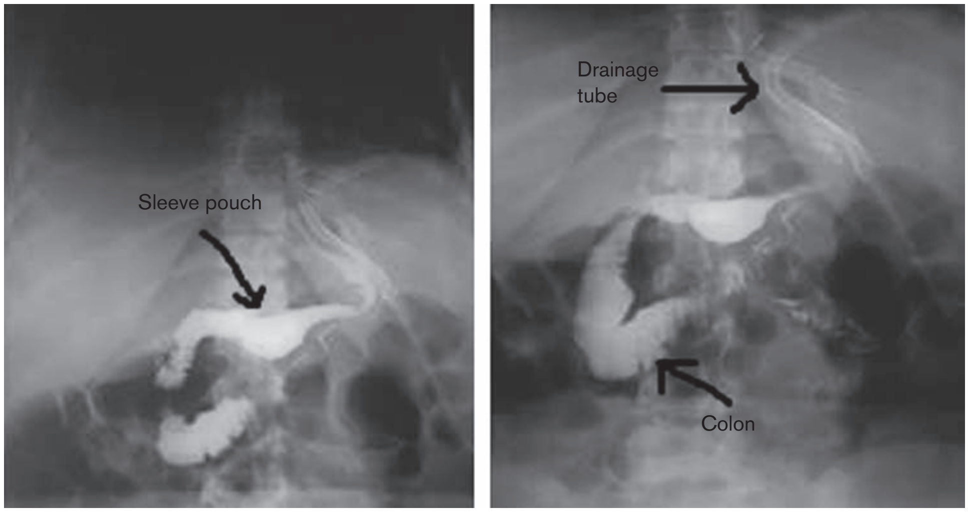
Considering the early performance of the gastric emptying study at 4–6 weeks after LSG and with respect to starting the stage of eating solid foods, the small size of the pouch after surgery, and the nauseating effect of fried or cooked eggs, we practiced a modified technique of AQ6
labeling a boiled egg with the ^{99m}Tc–sulfur colloid (total activity of 1 mCi), which would be more tolerable for patients after LSG, instead of cooking or frying as described in other studies [5–8].

This procedure was carried out as shown in Fig. 2, using a syringe with a small-gauge needle to pierce the shell of the raw egg carefully and then inject the tracer inside the egg. The site of puncture was sealed with a small piece of adhesive tape to prevent the fluid inside the egg from coming out of the shell during boiling. The labeled egg was then boiled for a few minutes for consumption. For the baseline study, the patients ingested two labeled AQ7
boiled eggs in a sandwich (~300 g). For the postoperative study, one labeled egg was ingested in a sandwich (~100 g). A sequential static acquisition was started immediately after the patient completed the meal, obtaining a 1-min frame at 0, 30, 60, 90, and 120 min.

Data processing AQ9

The activity in the entire stomach or in the remaining sleeve was visually assessed to draw regions of interest (ROIs), including any visualized activity in the proximal and distal regions, with care taken to adjust the ROI to

Fig. 1



Gastrografin meal and follow-through 24 h after LSG shows homogenous opacification of the remaining pouch, with no evidence of leakage, stenosis, or gastroesophageal reflux. The drainage tube was observed in the left subphrenic space.

avoid activity from the adjacent small bowel in anterior and posterior views of the composite image (Fig. 3).

For the liquid study, a time–activity curve was generated from which the half gastric-emptying time ($T1/2$) was derived from an exponential fit that was decay-corrected. ROIs were drawn at the first-minute image to calculate total counts and the percentage of tracer retention at 15, 30, and 60 min. Background correction was not performed as the orally ingested radiotracer did not measurably leave the gastrointestinal tract during the course of the study.

For the solid study a geometric mean (the square root of the product of counts in the anterior and posterior ROIs) was obtained simultaneously during acquisition of anterior and posterior views. A time–activity curve of the geometric means of gastric counts at all time points was constructed, and gastric retention at 30, 60, 90, and 120 min after meal ingestion was calculated as a percentage of the counts obtained at the first image (0 time, 100%). The $T1/2$ emptying time for the solid meal was computed by interpolation of the observed data.

Statistical methods

Data were statistically described as means and SDs, medians and ranges, or as frequencies (number of cases) and percentages when appropriate. Numerical variables between the study groups were compared using the Student *t*-test for independent samples. Within-group comparison of numerical variables was made using a paired *t*-test. For comparing categorical data, the χ^2-test was used. The exact test was used when the expected frequency was less than 5. *P*-values less than 0.05 were considered statistically significant. All statistical calculations were carried out using SPSS (SPSS Inc., Chicago, Illinois, USA) version 15 for Microsoft Windows.

Results

BMI significantly decreased in the studied groups after LSG, as shown in Table 1.

The quantitative results for gastric emptying were compared before and after LSG for both the liquid and the solid group.

For both liquids and solids, the half emptying time ($T1/2$) was significantly enhanced for patients after LSG compared with baseline ($P < 0.001$; Table 2).

Patients demonstrated a highly significantly smaller percentage of tracer retention for liquids at 15, 30, and 60 min after LSG compared with baseline ($P < 0.001$; Table 3).

Similarly, patients demonstrated a highly significantly smaller percentage of tracer retention for solids at 30, 60, 90, and 120 min after LSG compared with baseline ($P < 0.001$; Table 4).

Figures 4 and 5 show gastric-emptying scintigraphic images for two obese patients before and after LSG for liquids and solids.

Discussion

In the vast majority of affected individuals, obesity involves overconsumption of food relative to caloric requirements. The sensory function of the stomach may play a key role in the cessation of food ingestion. This sensation of the stomach is, in part, determined by its

Fig. 2

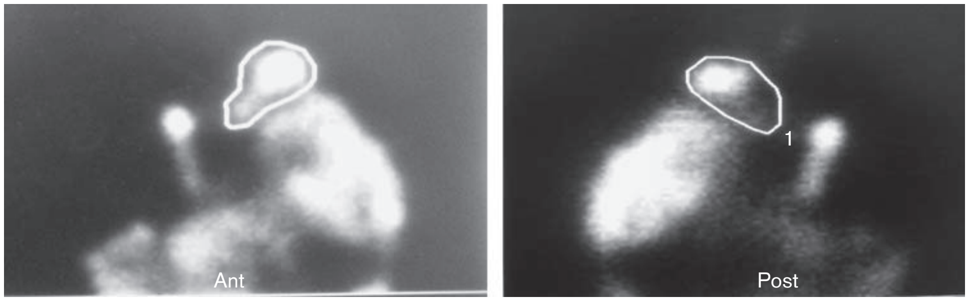
AQ8 Steps of labeling a raw egg with 1 mCi of the ^{99m}Tc–sulfur colloid in preparation for boiling. (a) Gentle piercing of the shell of the egg with a needle. (b) Injection of the radiotracer. (c) Sealing the site of puncture with adhesive tape. (d) Boiling the labeled eggs in water.

motor functions, such as tone and compliance, and the rate of emptying. However, studies on gastric emptying in normal-weight and obese individuals have shown inconsistent results [9].

AQ13 The mechanisms that affect gastric emptying after LSG include removal of the fundus, which has receptive and propulsive abilities; altered compliance and contractility of the narrow, hardly distendable sleeve; removal of the gastric pacemaker area in the body of the stomach; and impediment of the action of the antral pump if a part of the antrum is resected [10].

After LSG, the gastric reservoir function is reduced substantially because the gastric receptive relaxation or accommodation is eliminated owing to gastric resection

Fig. 3



AQ10 Regions of interest (ROIs) including any visualized activity in the proximal and distal parts of the sleeve to calculate counts from the geometric means of anterior and posterior images.

Table 1 BMI of the studied groups before and after LSG, with comparison

	Liquid group ($N=20$)		Solid group ($N=20$)	
	Baseline	1–4 weeks after LSG	Baseline	4–6 weeks after LSG
BMI (mean ± SD) (kg/m^2)	48.7 ± 3.3	40.5 ± 3.2	49.1 ± 7.1	37.7 ± 4.4
P	< 0.001		< 0.001	
% Weight loss	16.8%		23.2%	

LSG, laparoscopic sleeve gastrectomy.

Table 2 Half gastric-emptying time (*T*1/2) for liquids and solids in obese patients before and after LSG

	Half gastric-emptying time (min)		
	Baseline (mean ± SD)	LSG (mean ± SD)	*P*-value
Liquids ($N=20$)	25.3 ± 4.4	11.8 ± 3.0	< 0.001
Solids ($N=20$)	74.9 ± 7.1	28.4 ± 8.3	< 0.001

LSG, laparoscopic sleeve gastrectomy.

Table 3 % Gastric retention for liquids in obese patients before and after LSG

	% Gastric retention for liquids		
	15 min	30 min	60 min
Baseline (mean ± SD)	69.4 ± 10.5	55.6 ± 14.9	26.1 ± 4.7
LSG (mean ± SD)	33.9 ± 5.6	17.7 ± 3.9	7.5 ± 2.8
P-value	< 0.001	< 0.001	< 0.001

LSG, laparoscopic sleeve gastrectomy.

Table 4 % Gastric retention for solids in obese patients before and after LSG

	% Gastric retention for solids			
	30 min	60 min	90 min	120 min
Baseline (mean ± SD)	79.9 ± 8.7	67.4 ± 12.2	37.0 ± 10.9	13.8 ± 4.4
LSG (mean ± SD)	42.0 ± 11.1	20.8 ± 6.1	11.0 ± 5.9	3.8 ± 2.7
P-value	< 0.001	< 0.001	< 0.001	< 0.001

LSG, laparoscopic sleeve gastrectomy.

and, as a consequence, secondary rapid emptying to the antrum and duodenum can be observed [11].

For patients included in the current study, changes in functional motility including accommodation, trituration, and emptying occurred as a result of alteration of the normal gastric motor function after major resection of the fundus and corpus, resulting in rapid passing to the duodenum. The pacemaker region activity was deeply modified because a wide resection in this neuromuscular area was carried out. Yet, the propulsion function of the partially excised antrum remained almost intact because antral innervation remained intact [2].

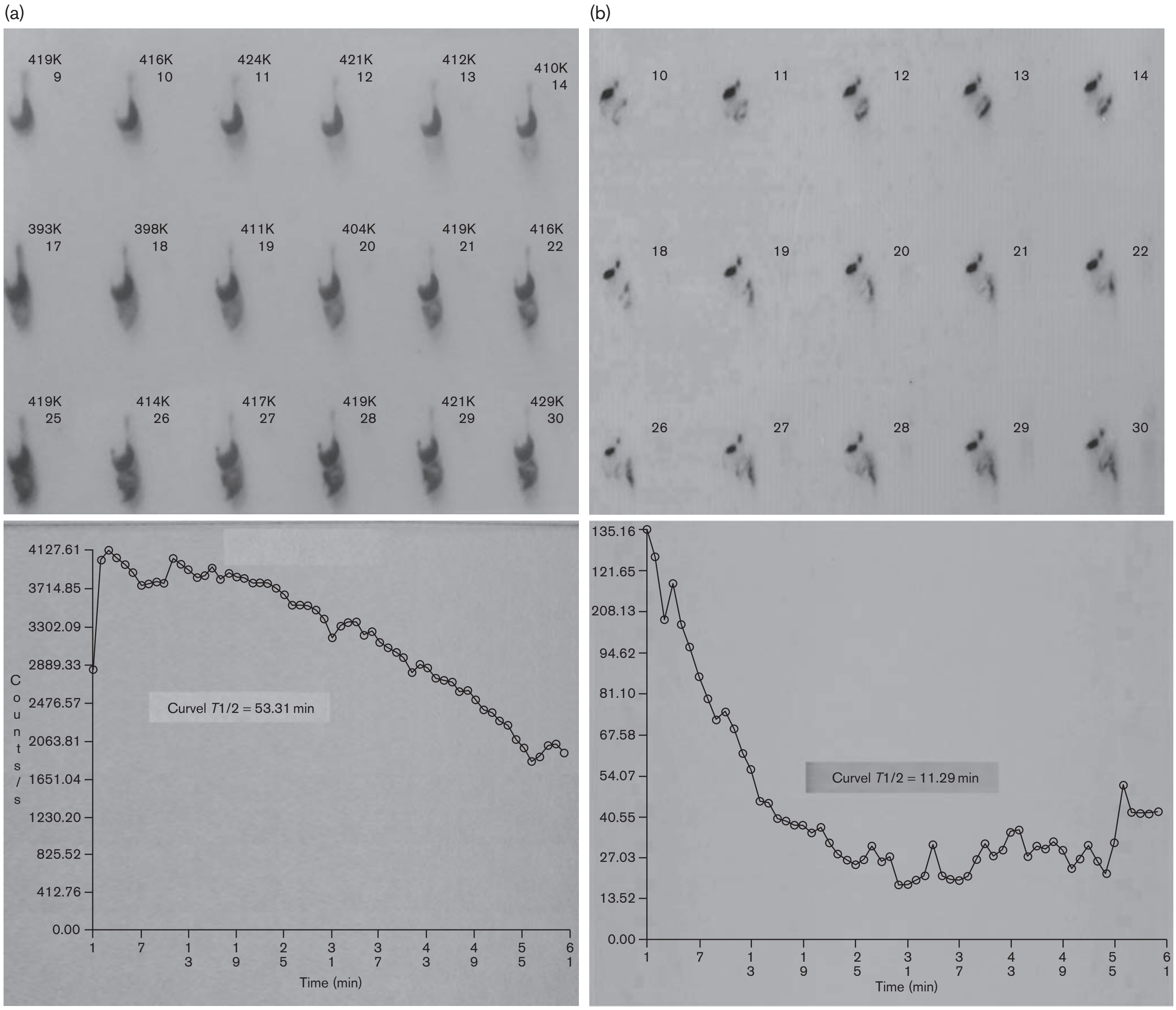
To our knowledge, this is the first study to perform radionuclide gastric emptying in patients who had undergone LSG shortly after surgery (2–3 weeks for liquids and 4–6 weeks for solids).

Further, after surgery, patients started to introduce solid food in their diet after the first month of surgery. Thus, we aimed to study the motility of the gastric sleeve at the time of maximum weight loss compared with baseline. AQ14

There are at present several operative techniques for LSG with respect to the distance of the incision from the pylorus, which subsequently alters gastric emptying. Bernstine *et al.* [6] preferred to make the incision at 6 cm proximal to the pylorus, emphasizing the importance of protecting the anatomical and functional integrity of the antrum of the stomach and explaining that the emptying function when measured with a standard semisolid meal was not affected 3 months after surgery. This was not the case in our study, in which the incision was made at 3–4 cm, which reduces the capacity of the antrum, allowing for enhanced gastric emptying, as reported by several studies using the same operative technique [12, 13]. AQ15

In the current study, significantly enhanced emptying of liquids and solids was observed compared with baseline results for the same group of patients. Our results are in agreement with those of Braghetto *et al.* [12]. However,

Fig. 4



	*T*1/2 Emptying	% Retention 15 min	% Retention 30 min	% Retention 60 min
Baseline	53.3 min	82	69.5	38.4
LSG	11.3 min	38	15	4

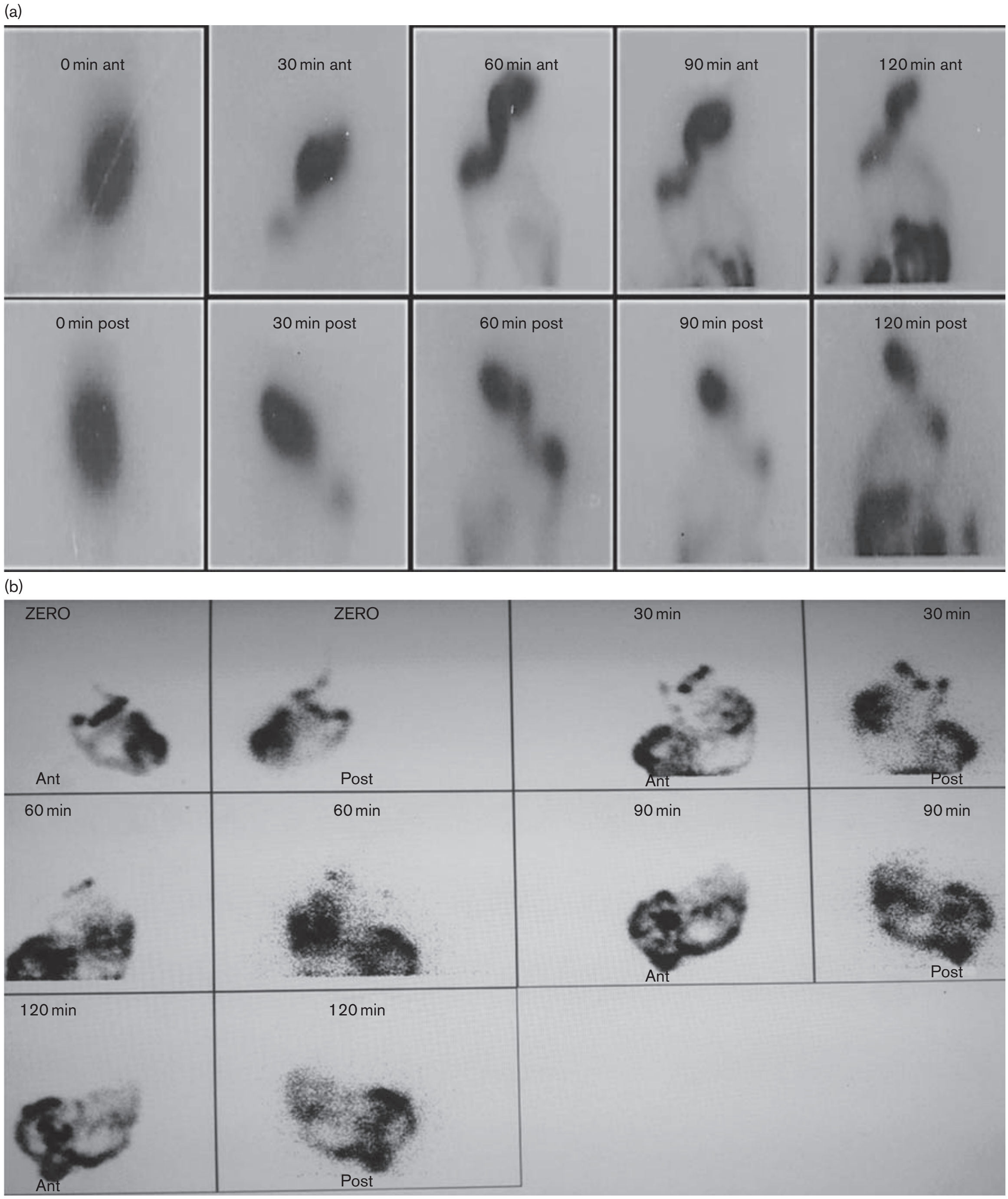
LSG, laparoscopic sleeve gastrectomy; *T*1/2, half gastric-emptying time.

AQ12 Liquid gastric-emptying images of a 28-year-old female patient (a) 8 days before and (b) 14 days after sleeve gastrectomy.

our quantitative indices including half emptying time and percentage gastric retention for both liquid and solid meals were obviously lower than their results. This difference could be attributed to the time of performing the study, as they evaluated their patients 3 months after LSG.

In agreement with our results, Melissas *et al.* [13] found that the gastric-emptying half-time for solid meals in their 14 patients accelerated significantly postoperatively, from 86.50 to 62.5 min at 6 months and to 60.80 min at 24 months after sleeve gastrectomy (SG; $P < 0.05$); the percentage of gastric emptying also increased

Fig. 5



	*T*1/2 Emptying	% Retention 30 min	% Retention 60 min	% Retention 90 min	% Retention 120 min
Baseline	80 min	85	77	45	14
LSG	36 min	43	22	7.5	2.5

LSG, laparoscopic sleeve gastrectomy; *T*1/2, half gastric-emptying time.

Solid gastric-emptying images of a 40-year-old male patient (a) 10 days before and (b) 5 weeks after sleeve gastrectomy.

significantly postoperatively, from 52 to 72% at 6 months and to 74% at 24 months after SG ($P<0.05$). However, our indices still indicate more accelerated emptying, supporting our findings that gastric motility is more enhanced in the short term after LSG.

Another important mechanism involved in fast gastric emptying after SG is the volume/pressure ratio, suggested by Yehoshua and colleagues. The intragastric pressure is significantly increased in patients who have undergone this operation, reaching up to 40 mmHg (32–58 mmHg), compared with 19 mmHg (11–26 mmHg) in an intact stomach. This higher pressure reflects its lesser distensibility and is a factor promoting fast gastric emptying when antrum resection is performed [14,15]. Therefore, the increased intragastric pressure also promotes fast gastric emptying, considering that the antral pump function does not change because vagal innervation through Latarjet's nerve remains intact [12].

It is documented that maximum weight loss occurs in the initial weeks after surgery, and the rate of weight loss declines with time. In the current study, the percentage reduction in BMI following LSG was 16.8 and 23.2% at 2–3 and 4–6 weeks after surgery, respectively. The mechanism of weight loss after LSG is multifactorial and it cannot be assumed that a single factor contributes to
AQ16 this weight loss. In patients who have undergone LSG, a decreased release of ghrelin has been reported, and therefore patients experience reduced appetite with a consequent modification in the food intake behavior, with a reduction in caloric intake [16,17]. Furthermore, the occurrence of the dumping syndrome more frequently in the early period after LSG could be attributed to rapid gastric emptying, which may explain the maximum weight loss shortly after surgery [18].

Accelerated gastric emptying after LSG contributes to the digestive process by enhancing satiety signals. Therefore, the mechanisms of weight loss and improvement in glucose metabolism that are seen after LSG are related not only to gastric restriction but also to neurohormonal changes related to gastric resection and altered gastric emptying [19].

Conversely, after LSG, a negative impact with respect to the risk of weight regain can occur because rapid emptying could reduce the negative feedback satiety signals produced by the nutrients inside the stomach, thus precipitating a feeling of hunger and thereby shortening the interval between consecutive meals. However, these alterations can be considered as potential contributing factors to the development and maintenance of obesity and changed eating behavior [20–23].

Our study showed more rapid baseline gastric-emptying indices in obese patients compared with that by Braghetto *et al.* [12], who performed the baseline study on normal individuals. This finding confirms the assumption that obese patients present more rapid gastric emptying compared with nonobese individuals, and therefore they eat more frequently. However, altered gastrointestinal motility in obese patients is incompletely understood and is controversial in the literature [20,21,23,24]. Thus, we recommend more gastric motility studies to clarify the effect of gastric emptying on the percentage of weight loss or weight regain over different time intervals in obese patients after LSG.

Conclusion

The significant acceleration of gastric emptying for liquids and solids after LSG may have contributed to weight loss in the immediate postoperative period (4–6 weeks). It remains to be determined whether the weight loss will continue beyond that period.

Acknowledgements

The authors thank Maged Malak, The Nuclear Medicine Technician, for his contributions in the preparation and labeling of eggs, as well as in data processing.

Conflicts of interest

~~None declared.~~ AQ17

References

1 Msika S, Castel B. Present indications for surgical treatment of morbid obesity: how to choose the best operation? *J Visc Surg* 2010; **147** (5 Suppl): e47–e51.

2 Verdich C, Madsen JL, Toubro S, Buemann B, Holst JJ, Astrup A. Effect of obesity and major weight reduction on gastric emptying. *Int J Obes Relat Metab Disord* 2000; **24**:899–905.

3 Abell TL, Camilleri M, Donohoe K, Hasler WL, Lin HC, Maurer AH, *et al.* American Neurogastroenterology and Motility Society and the Society of Nuclear Medicine. Consensus recommendations for gastric emptying scintigraphy: a joint report of the American Neurogastroenterology and Motility Society and the Society of Nuclear Medicine. *Am J Gastroenterol* 2008; **103**:753–763.

4 Ziessman HA, Bonta DV, Goetze S, Ravich WJ. Experience with a simplified, standardized 4-hour gastric-emptying protocol. *J Nucl Med* 2007; **48**:568–572.

5 Abell TL, Camilleri M, Donohoe K, Hasler WL, Lin HC, Maurer AH, *et al.* American Neurogastroenterology and Motility Society and the Society of Nuclear Medicine. Consensus recommendations for gastric emptying scintigraphy: a joint report of the American Neurogastroenterology and Motility Society and the Society of Nuclear Medicine. *J Nucl Med Technol* 2008; **36**:44–54.

6 Bernstine H1, Tzioni-Yehoshua R, Groshar D, Beglaibter N, Shikora S, Rosenthal RJ, Rubin M. Gastric emptying is not affected by sleeve gastrectomy – scintigraphic evaluation of gastric emptying after sleeve gastrectomy without removal of the gastric antrum. *Obes Surg* 2009; **19**:293–298.

7 Tougas G, Eaker EY, Abell TL, Abrahamsson H, Boivin M, Chen J, *et al.* Assessment of gastric emptying using a low fat meal: establishment of international control values. *Am J Gastroenterol* 2000; **95**:1456–1462.

8 Knight LC, Kantor S, Doma S, Parkman HP, Maurer AH. Egg labeling methods for gastric emptying scintigraphy are not equivalent in producing a stable solid meal. *J Nucl Med* 2007; **48**:1897–1900.

9 Park MI, Camilleri M. Gastric motor and sensory functions in obesity. *Obes Res* 2005; **13**:491–500.

10 ~~Tzioni-Yehoshua R, Eidelman AL, Stein M, *et al.* Laparoscopic sleeve gastrectomy – volume and pressure assessment. *Obes Surg* 2008; **18**:1083–1088.~~ AQ18

11 Grybäck P, Näslund E, Hellström PM, Jacobsson H, Backman L. Gastric emptying of solids in humans: improved evaluation by Kaplan–Meier plots,

with special reference to obesity and gender. *Eur J Nucl Med* 1996; **23**:1562–1567.

12 Braghetto I, Davanzo C, Korn O, Csendes A, Valladares H, Herrera E, *et al.* Scintigraphic evaluation of gastric emptying in obese patients submitted to sleeve gastrectomy compared to normal subjects., *Obes Surg* 2009; **19**:1515–1521.

13 Melissas J, Daskalakis M, Koukouraki S, Askoxylakis I, Metaxari M, Dimitriadis E, *et al.* Sleeve gastrectomy – a "food limiting" operation. *Obes Surg* 2008; **18**:1251–1256.

14 Yehoshua RT, Eidelman LA, Stein M, Fichman S, Mazor A, Chen J, *et al.* Laparoscopic sleeve gastrectomy – volume and pressure assessment. *Obes Surg* 2008; **18**:1083–1088.

15 Rubin M, Yehoshua RT. The role of the various factors contributing to the reduction of food intake following sleeve gastrectomy. Proceedings of the 2nd Annual International Consensus Summit for Sleeve Gastrectomy ICSSG-2 Miami; March 2009.

AQ19

16 Cohen R, Uzzan B, Biham H, Khochtali I, Reach G, Catheline JM, *et al.* Ghrelin level and sleeve gastrectomy in superobesity. *Obes Surg* 2005; **15**:1501–1502.

17 Deitel M, Crosby RD, Gagner M. The First International Consensus Summit for Sleeve Gastrectomy (SG), New York City, October 25–27, 2007. *Obes Surg* 2008; **18**:487–496.

18 Altuve J, Gonzales R, Aceituno L. Does sleeve gastrectomy really avoid dumping syndrome? 2nd Annual International Consensus Summit for Sleeve gastrectomy ICSSG-2 Miami; 2009.

19 Melissas J, Daskalakis M. Gastric emptying after sleeve gastrectomy. *Obes Surg* 2011; **21**:1810–1811.

20 Pereferrer FS, Gonzàlez MH, Rovira AF, Blasco SB, Rivas AM, del Castillo Déjardin D. Influence of sleeve gastrectomy on several experimental models of obesity: metabolic and hormonal implications. *Obes Surg* 2008; **18**:97–108.

21 Santoro S, Milleo FQ, Malzoni CE, Klajner S, Borges PC, Santo MA, *et al.* Enterohormonal changes after digestive adaptation: five-year results of a surgical proposal to treat obesity and associated diseases. *Obes Surg* 2008; **18**:17–26.

22 Moon-In P, Camilleri M. Gastric motor and sensory function in obesity. *Obes Res* 2005; **13**:481–500.

23 Gallagher TK, Geoghegan JG, Baird AW, Winter DC. Implications of altered gastrointestinal motility in obesity. *Obes Surg* 2007; **17**:1399–1407.

24 Vidal J, Ibarzabal A, Romero F, Delgado S, Momblán D, Flores L, Lacy A. Type 2 diabetes mellitus and the metabolic syndrome following sleeve gastrectomy in severely obese subjects. *Obes Surg* 2008; **18**:1077–1082.

AUTHOR QUERY FORM

LIPPINCOTT
WILLIAMS AND WILKINS

JOURNAL NAME: MNM
ARTICLE NO: NMC_11_1562
QUERIES AND / OR REMARKS

QUERY NO.	Details Required	Author's Response
Q1	As per style, the short title running head should contain a maximum of 50 characters (including spaces). Hence, please provide a new one of the above specifications.	Gastric emptying study after sleeve gastrectomy
Q2	Please provide tel (landline) and fax details for the corresponding author.	tel: 002 02 38336673 fax: 002 02 23635554
Q3	Please clarify whether the changes made in the sentence beginning 'Radionuclide studies…' retain its intended meaning.	ok
Q4	Please confirm whether the changes made to the sentence "First, the greater omentum attached to…." retain the intended meaning.	ok
Q5	Please confirm whether the changes made to the sentence "The first stapling cartridge was green (4.1 mm) for…." are correct.	ok
Q6	Please confirm whether the changes made to the sentence "Considering the early performance of the GE…" are OK.	ok
Q7	Please clarify whether the deletion of 'bread' in the sentence beginning 'For the baseline study…' is correct.	ok
Q8	Please clarify whether the changes made in the caption of Figure 2 are correct.	ok
Q9	Please clarify whether the hierarchy of the section headings is correct.	correct
Q10	Please provide the significance of 1 in Fig 3.	non-significant, plz. omit it
Q11	Please confirm whether the changes made to the paragraph " For the liquid study , a time–activity curve was…." are correct.	ok
Q12	Please check the term 'Curvel' in Fig .4 and clarify any change required.	it is automatically generated during data processing but it dosenot have any significance, can be omitted if possible

AUTHOR QUERY FORM

LIPPINCOTT
WILLIAMS AND WILKINS

JOURNAL NAME: MNM
ARTICLE NO: NMC_11_1562
QUERIES AND / OR REMARKS

QUERY NO.	Details Required	Author's Response
Q13	Please clarify whether the changes made in the sentence beginning 'The mechanism that affects…' are appropriate.	ok
Q14	Please verify whether the changes made to the sentence "Further, after surgery, patients started to introduce…." retain the intended meaning.	ok
Q15	Please check whether the changes made to the paragraph "There are at present several operative techniques….operative technique." are correct.	ok
Q16	Please clarify whether the changes made in the sentence beginning 'In patients who have…' are appropriate.	ok
Q17	Please provide the details of 'the conflict of interest disclosure'. If there is nothing to declare, please provide a statement to that effect.	There are no conflicts of interest.
Q18	Please check reference [10] as this reference cannot be found in Pub Med, and the journal title and other details match with the details provided in ref. [14].	ref [10] is corrected ref [14] is omitted because it is repeated from ref [10] and is replaced by ref [10] in the text. rest of ref. are adjusted accordingly in text and reference section
Q19	Please provide the date and place of the proceedings.	i could not find any date or place???