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CLINICAL REPORT

Evaluation of the Radiological Gastric Capacity and Evolution of the BMI 2–3 Years After Sleeve Gastrectomy

Italo Braghetto · Claudio Cortes · David Herquiñigo · Paula Csendes · Alejandro Rojas · Maher Mushle · Owen Korn · Héctor Valladares · Attila Csendes · Ana Maria Burgos · Karin Papapietro

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Abstract
Background Sleeve gastrectomy is a restrictive procedure for treatment of obese patients with different body mass index (BMI) and presents good results in terms of a reduction of percentage of excess weight loss and BMI. There is no consensus which is the optimal technique regarding to the diameter of the gastric tube, but a capacity of 100–120 ml has been suggested. In this prospective study, we compare the gastric capacity evaluated with barium sulfate or computer-aided tomography (CAT) scan early and 24 months after operation compared to the changes in body weight and BMI reduction in a small group of 15 consecutive patients submitted to sleeve gastrectomy.
Methods Fifteen successive obese patients submitted to laparoscopic sleeve gastrectomy were included. They were studied in order to measure the residual gastric capacity with barium sulfate and CAT scan early (3 days) and late (2 years) after surgery.
Results The early postoperative gastric volume was 108± 25 ml (80–120 ml) and 116.2±78.24 assessed with barium sulfate and CAT scan, respectively. The gastric capacity at the late control increased to 250±85 and 254±56.8 assessed with the same techniques. However, patients remained stable with a BMI close to 25 without regain of weight at least at the time of observation.
Conclusions Gastric capacity can increase late after sleeve gastrectomy even after performing a narrow gastric tubulization. It is very important to measure objectively residual gastric volume after sleeve gastrectomy and its eventual increase in order to determine the late clinical results and to indicate eventual strategy for retreatment.

Keywords Obesity · Sleeve gastrectomy · Radiology

I. Braghetto (✉) · M. Mushle · O. Korn · H. Valladares · A. Csendes · A. Maria Burgos · K. Papapietro
Department of Surgery, University Hospital, University of Chile, Santos Dumont 999,
Santiago, Chile
e-mail: ibraghet@edclinicauchile.cl

C. Cortes · D. Herquiñigo · P. Csendes · A. Rojas
Department of Radiology, University Hospital,
University of Chile,
Santiago, Chile

Introduction

As a restrictive procedure, sleeve gastrectomy (SG) presents successful results in terms of decrease of body mass index (BMI), percentage of loss of excess weight, and improvement of comorbidities [1–3]. Concerning the diameter of the bougie employed for performing the gastric tube, there is no consensus, but an optimal gastric capacity of 100–120 ml has been suggested [4–6]. There are no available data on the literature reporting the results regarding the evolution of the size of the gastric tube at middle- or long-term follow-up correlated to the regain of weight or re-increase of the BMI. Some case reports have demonstrated increase of gastric size and volume of the stomach 3 years after the operation in which a reoperation must be indicated for regain of body weight [7, 8]. Similar results concerning the percentage of excess weight have been reported independently of the bougie 40F or 60F used while performing sleeve gastrectomy [9].

In this prospective study, we present the results after 2–3 years follow-up evaluating the capacity of the gastric tube

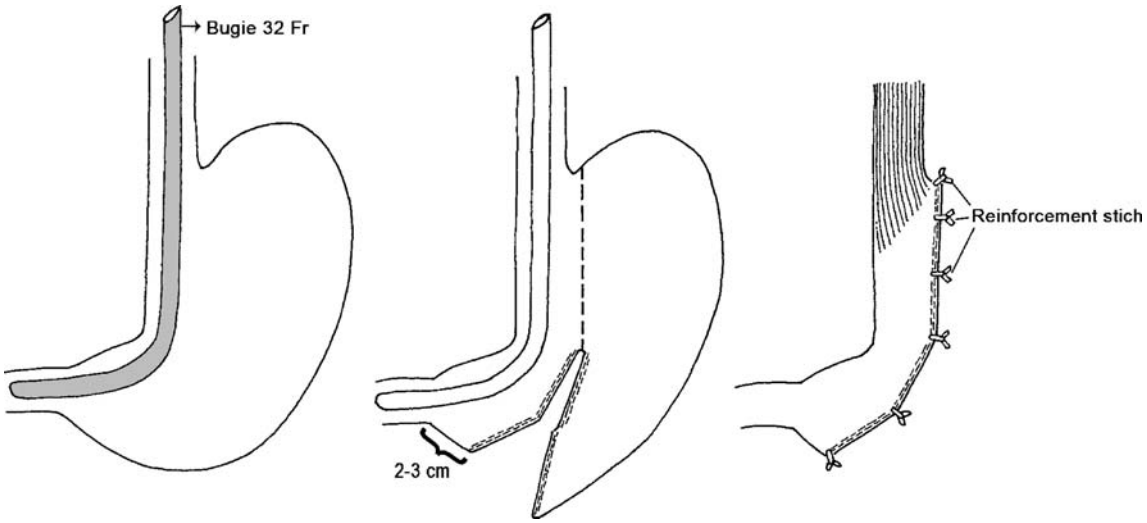

Fig. 1 Sleeve gastrectomy performed over a 32F bougie with a gastric transection starting 2.3 cm from the pylorus to 1 cm to the His's angle

and the evolution of the body weight loss and BMI decrease.

Patients

Fifteen successive obese patients were included in this prospective study (from January 2005 to October 2008) who were submitted to sleeve gastrectomy. They correspond to three men and 12 women with a mean age of 34.6 years (range 23–48) The mean body weight was 112.8 kg (range 95–151), and the mean BMI was 39.7, (range 32.8 to 48). They were submitted to several measurements of gastric capacity early and late after surgery.

Surgical Procedure and Intraoperative Gastric Capacity Measurement

When the greater curvature is exposed, using a Ligasure device (Covidien, Cincinnati, USA), the gastroepiploic gastric branches are divided starting at 2 cm from the pylorus until the His's angle, cutting the short gastric and posterior fundic vessels. Once this maneuver is completed, a 32 French bougie is introduced by the anesthesiologist to the stomach, and the surgeon pushes it along the lesser curvature into the pyloric channel and duodenal bulb. Then, an endogia device 4.8 mm stapler (green charge) is introduced by the 15 mm port located at the right quadrant in order to start the division of the antrum 2–3 cm from the pylorus, which is completed with another green charge up to the angular incisure. The gastric tubulization is performed by division of the gastric corpus straight to the His's angle applying three to four charges of 3.8 mm stapler endogia (blue charge; Fig. 2). Then, reinforcement with absorbable stitches over the mechanical suture is performed, leaving a small gastric tubular pouch of 60–80 ml capacity measured by the instillation of methylene blue through a nasogastric tube placed after the pull off of the bougie, with the purpose to exclude leaks of the suture line and evaluation of the gastric capacity. For this purpose, we block transitorily the flux to the duodenum with a long intestinal forceps just in the postpyloric site. In this fashion, a narrow tube is obtained (Figs. 1 and 2)

Fig. 2 Radiological evaluation with barium sulfate at the third postoperative day showing a very narrow gastric tube

Table 1 Changes in the gastric capacity early and late after surgery

	Gastric capacity (ml)	
	Early(3days)	Late(2–3years)
Intraoperative (methylene blue)	70±22 (60–80)	–
Postoperative barium swallow	108±25 (60–120) (a)	250±85 (200-300) (b)
CAT scan	116.2±78.24 (62–206) (c)	254±56.8 (208–324) (d)

a vs b, p=0.000; a vs c, p=0.733; c vs d, p=0.000; b vs d, p=0.893

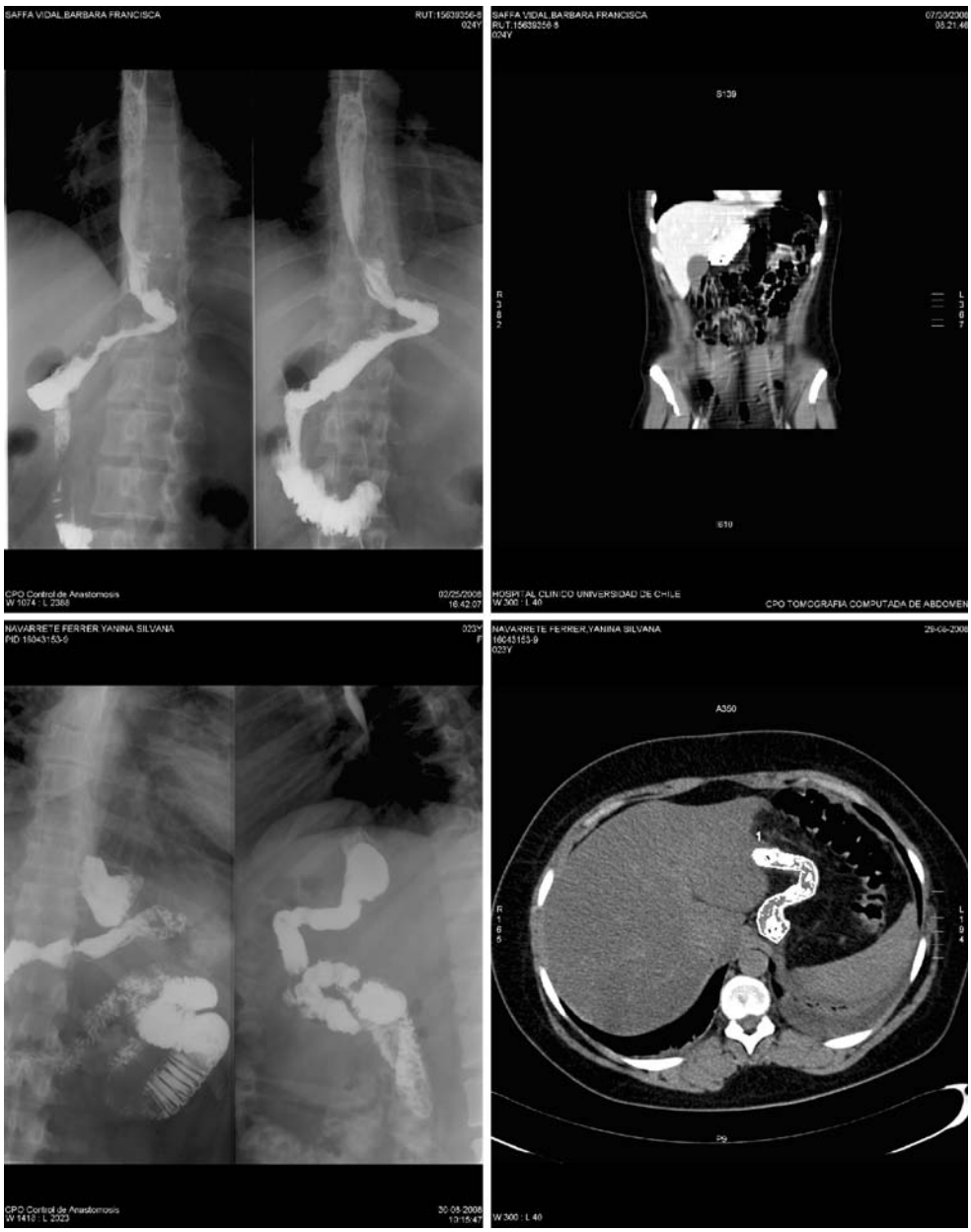

Fig. 3 Radiological image with barium sulfate and CAT scan early after surgery demonstrating a narrow tube

Postoperative Gastric Capacity Measurement

The gastric capacity was measured on the third postoperative day by radiological assessment with barium sulfate swallow and not hydrosoluble contrast in order to have a good and clear representation of the gastric tube and in this way to measure its capacity in milliliter. Barium sulfate does not produce any complication or sequelae outside of gastrointestinal tract. This examination also was performed in order to exclude postoperative leaks. Besides, computer-aided tomography (CAT) scan was performed with the same purpose.

A CAT helicoidal acquisition is performed in a Siemens CAT model somaton sensation 64. Standard scanning parameters for abdominal imaging were the following: collimation, 1.2; pitch, 1.4; effective slice thickness, 3.2 mm. Immediately before entering the CAT console, the patient is ordered to drink

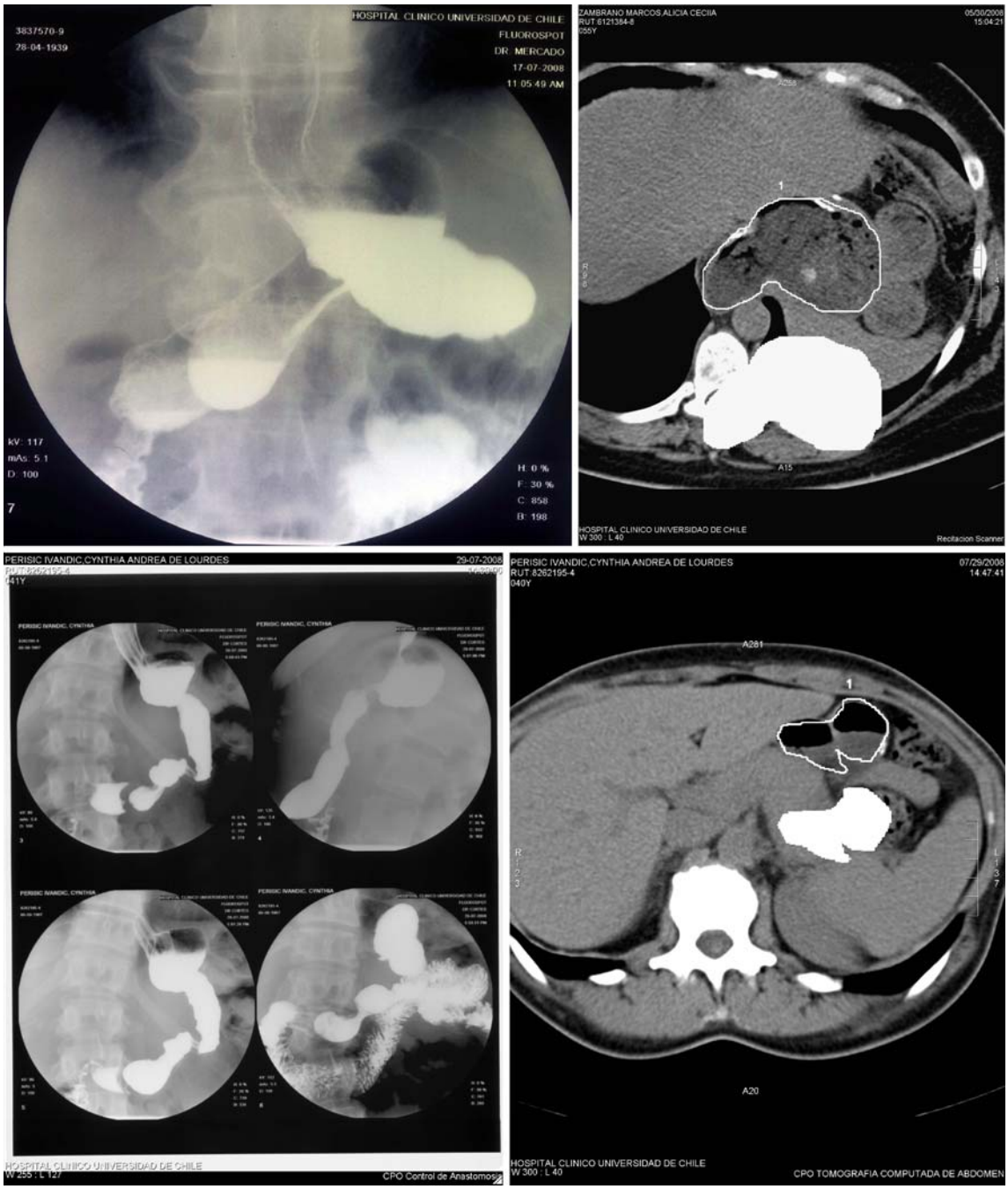

Fig. 4 Radiological image with barium sulfate and CAT scan late after surgery demonstrating an increased image and increased gastric capacity in the same patients

as much water as tolerated. A post processing work station console consisting of a volumetric evaluation program as well as the images obtained on previous CATs is used. On successive axial images, the remaining stomach's contour is marked, thus obtaining the gastric volume using computer extrapolation software.

Nutritional Indications after Sleeve Gastrectomy

Patients at discharge from the hospital receive precise instruction regarding to the technique of food and liquid intake. During the first week they receive a fractioned liquid diet of no more than 100 cc of volume, 600–800 cal, 60–80 g of proteins per day; afterwards, they continue with semisolids foods for 4 weeks. At that time, they start to receive fractioned solid food not more than 200–250 cc of total volume each.

Late Gastric Capacity Measurement

The same evaluation was done 24–36 months after the operation with the same technique in order to study changes in the size and capacity of the gastric tube.

Body weight and BMI reduction were also controlled in all of these patients

For statistical analysis, we use chi-square test.

Results

Table 1 shows the changes in the gastric capacity early and late after surgery. The mean gastric capacity measured with methylene blue at the end of the procedure through a nasogastric tube was 70±22 ml. The gastric capacity early after the operation was 108±25 ml and 116.2±78.2, assessed by barium or CAT scan, respectively ($p>0.5$). Fig. 3 shows the radiological images and capacity obtained by radiological study with barium sulfate and CAT scan. At the late control, the mean capacity of the stomach increased from 108±25 ml to 250±85 ml measured with barium sulfate and from 116.2±78.2 to 254±56.8 ml at the CAT scan study. These values are significantly higher compared to the early measurement ($p=0.0000$). There were no significant differences between barium sulfate measurement compared to CAT scan measurement ($p>0.5$). Fig. 4 shows examples of radiological images obtained early and late after surgery with radiological and CAT scan assessment.

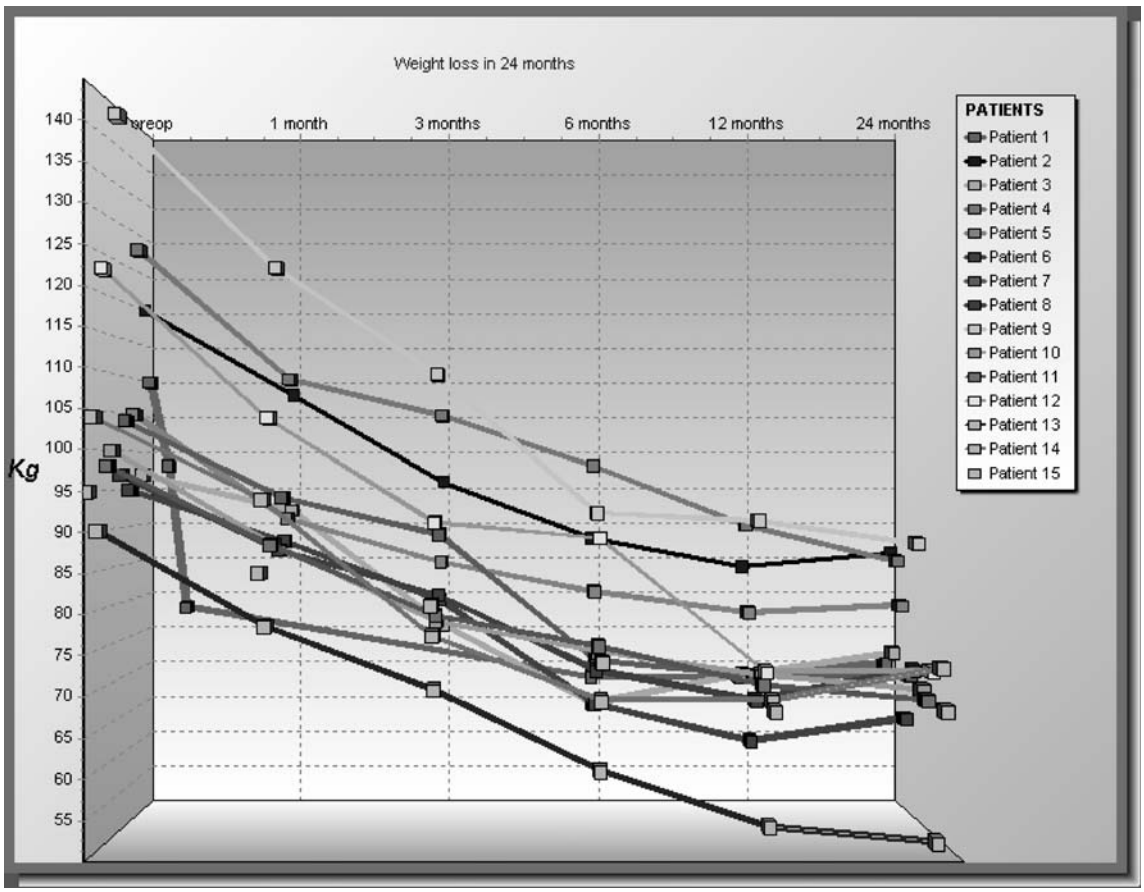

Fig. 5 Weight lost after surgery until 24 months of follow-up

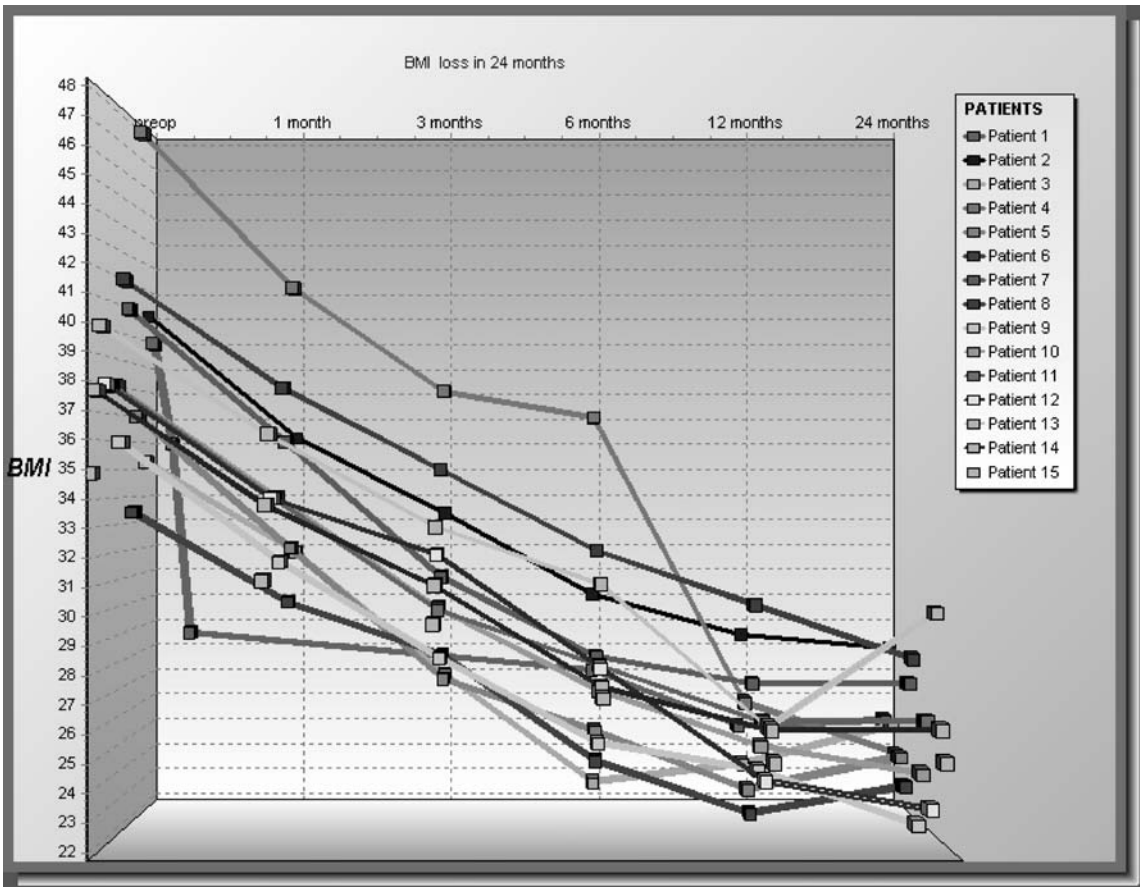

Fig. 6 BMI after the operation during the follow-up

The mean weight loss during the follow-up is shown in Fig. 5.

The body weight lost at the first month after surgery was 11.1±2.2 kg and reached to 45.5±5.2 kg at the sixth month without regain of weight during the 24–36 months of follow-up in almost all of them except in three cases. Also, BMI decreased progressively during the first year and remained stable close to 25 during the observation period, but in three patients, a slight increase of BMI was observed. Fig. 6 shows the evolution of the BMI during the follow-up.

Discussion

The results of the present study suggest that an important increase in the residual gastric capacity after sleeve gastrectomy may occur in some patients provided that objective radiological measurement are made early and late after surgery. This increase in gastric volume may be responsible for a regain in weight after this operation. We have measured the residual gastric volume very early (3 days) after surgery by two different radiological methods obtaining similar results: 108 ml measured by barium swallow and 116 ml by CAT scan. We have performed our surgical procedure with two differences compared to other data published by other surgeons:

(a) We use a bougie no. 32 in order to obtain a narrow gastric tube.
(b) We start at 2–3 cm from the pylorus, therefore resecting almost completely the antrum.

In the majority of the revised publications, the authors start 6–7 cm from the pylorus and therefore leave the antrum [2]. We wonder which is the residual gastric capacity after this method, which has not been measured by any of them. Some authors perform a narrower gastric tube over a 32–34 French bougie, leaving a "volume" of about 100 ml in order to increase the weight loss and avoid weight regain [4–6, 10–12], but these publications did not report objective results regarding measurement of gastric capacity. Therefore, we cannot compare our results with other publications. However, it would be very important that these measurements should be done routinely after surgery and in this way compare them at the late follow-up.

In regard to the size of bougie employed, there is no consensus, and there are several reports employing diameters from 32 to 60 French, without clear final results [13–15].

Parikh et al. [9] reported no significant differences concerning the diameter of the bougie used during the performance of sleeve gastrectomy and the loss of weight, but the follow-up was short. In the Wiener's report [4], the most restrictive laparoscopic sleeve gastrectomy performed over a 32F bougie for calibration of tubulization presented after 2 years follow-up better results than other patients calibrated over 40F bougie or without calibration, and recently during the Second International Consensus Summit of Sleeve Gastrectomy (ICSSG, Miami, March 2009) he reported increased sleeve volume from 34.4 ml to 141.2 cc assessed by CAT scan measurement, demonstrating pouch dilatation of the antrum or fundus associated with body weight regain. We do not use any other bougie diameter for calibration of the gastric tubulization, and therefore, we cannot compare late results regarding weight loss. Another publication compared the results of not employing bougie versus the use of 32 and 40F demonstrating better loss of weight when employing a bougie [4].

Independent of the diameter of bougie as guide employed for gastric tubulization, probably the characteristic of food intake technique and patient's alimentary habits are other factors for late increasing of gastric capacity. Although patients receive very precise instructions for the technique of food intake, some have progressive tendency to increase the size of meal due to anxiety. According to the Melissa's studies, patients present drastic reduction in meal size, but they have rapid gastric emptying; therefore, patients increase the frequency of food intake. Late after surgery, half of patients present increase in size meal and frequency [16, 17]. By other hand, Himpens et al. [18] report loss of feeling of hunger in 75% of patients 1 year after operation and in 46% after 2 years, but accelerated gastric emptying diminishes the satiety feeling. This observation is important because these patients without loss of satiety feeling have the necessity to eat more and more, then promoting gastric distension and increasing the gastric capacity.

We do not know the results at late follow-up of patients submitted to sleeve gastrectomy. In the present study including a small group of consecutive patients up to 2 years of follow up, although a significant increase in residual gastric capacity was observed comparing early measurements versus determinations at 2 years (from 110 to 250 ml), this increase did not reflect in a regain of weight until the end of the present study. We do not know whether this applies to all patients submitted to sleeve gastrectomy, but this observation must be taken in account for considering the late results after SG. However, it could be possible to postulate that an increase in weight may occur later at the follow-up if a wider gastric tube was performed initially, and therefore, it could be a warning for surgeons performing laparoscopic sleeve gastrectomy. That is why this group of patients must remain under close nutritional indications in order to avoid regain of body weight. Finally, for us it is very important to measure by objective methods the results of gastric resection. We employ barium sulfate which gives a much better visualization of gastric residual lumen, detects easily a leakage, and allows the determination of residual gastric volume that is very similar to the results obtained with CAT scan gastric capacity evaluation. In over 3,000 patients who received barium sulfate early after surgery in order to evaluate emptying, size of gastric pouch, and permeability of gastrojejunal anastomosis for different esophagogastric diseases, we have never observed any harmful effect of barium. We try to postulate what is necessary to state results based on objective estimation of the volume of residual stomach and not subjectively. It would be desirable that other surgical teams dedicated to bariatric surgery could perform objective measurements.

In conclusion, gastric capacity can increase late after sleeve gastrectomy even after performing a narrow gastric tubulization. It is very important to measure objectively residual gastric volume after sleeve gastrectomy and its increase in order to determine the late clinical results and to indicate the eventual strategy for retreatment.

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