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Laparoscopic sleeve gastrectomy: Correlation of gastric emptying and weight loss

Laparoskopik sleeve gastrektomi: Mide boşalması ve kilo kaybı arasındaki ilişki

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Abstract

Aim: Laparoscopic Sleeve Gastrectomy (LSG) has become a popular technique as a definitive procedure in obesity treatment. It has been linked to an alteration in gastric motility and gastric emptying. The purpose of the study is to analyze the changes in gastric emptying (GE) after LSG produces and its correlation with weight loss after surgery.

Methods: The preoperative and postoperative GE was estimated by gastric emptying scintigraphy at 1 month and 18 months in 52 successive patients who underwent LSG surgery. The gastric emptying scintigraphy was conducted after the ingestion of TC^{99m} sulfur colloid labeled solid food. Images were obtained using a gamma camera at 0, 30, 60, 120, 180 and 240 minutes. Calculations were made to find out the half time gastric emptying ($T_{½}$) and the retention percentage at 2 and 4 hours.

Results: The $T_{½}$ preoperatively, at 1 month and at 18 months were 101.1 (44) minutes, 88.6 (51.5) minutes and 80.7 (53) minutes, respectively (P<0.05). Before the operation, and at the 1st and 18th months postoperatively, the percentage of retention at 2 hours were 33.4% (17.4), 26.1% (18.5), and 28.6% (15.2), respectively (P<0.05), and that at 4 hours were 5.8% (18.3), 4.5% (16.2), and 2.8% (12.6), respectively (P>0.05). The volume of the gastric reservoir increased from 239.5 (88.7) ml to 280.8 (100.8) ml (P<0.05) at 1 and 18 months after the operation. There was an inverse correlation between GE and the weight loss data at the first postoperative month, which did not remain at the 18th postoperative month.

Conclusion: According to our series, LSG with an initial transection at 4 cm from the pylorus affects gastric emptying but is not significantly correlated with weight loss.

Keywords: Gastric emptying scintigraphy, Gastric volume, Weight loss, Sleeve gastrectomy, Morbid obesity

Öz

Amaç: Laparoskopik Sleeve Gastrektomi (LSG), obezite tedavisinde kesin çözüm olarak popüler bir teknik haline gelmiştir. LSG, mide motilitesi ve mide boşalmasında değişiklikle ilişkilendirilmiştir. Bu çalışmanın amacı, LSG sonrası mide boşalmasındaki (MB) değişiklikleri ve ameliyat sonrası kilo kaybı ile ilişkisini analiz etmektir.

Yöntemler: LSG ameliyatı geçiren 52 ardışık hastada mide boşalması, ameliyat öncesi ve ameliyattan sonraki 1 ve 18. aylarda, TC99m sülfür kolloid etiketli katı gıda alımından sonra, mide boşalma sintigrafisi ile değerlendirildi. Görüntüler 0, 30, 60, 120, 180 ve 240. dakikalarda bir gama kamera kullanılarak elde edildi. İkinci ve 4. saatlerde mide boşalmasının (T½) yarısı ve retansiyon yüzdesini bulmak için hesaplamalar yapıldı.

Bulgular: Ameliyat öncesi, ve postoperative 1 ve 18. Aylarda $T_{1/2}$ sırasıyla 101.1 (44) dakika, 88.6 (51.5) dakika ve 80.7 (53) dakika idi (P <0.05). Ameliyat öncesi ve ameliyat sonrası 1. ve 18. aylarda 2. saatteki retansiyon yüzdesi sırasıyla % 33.4 (17.4), % 26.1 (18.5) ve % 28.6 (15.2) (P <0.05), aynı değerler 4. saatte sırasıyla % 5.8 (18.3), % 4.5 (16.2) ve % 2.8 (12.6) idi (P> 0.05). Mide rezervuar hacmi operasyondan sonraki 1. ve 18. aylarda 239.5 (88.7) ml'den 280.8 (100.8) ml'ye (P <0.05) yükseldi. GE ile postoperatif ilk ayda kilo verme verileri arasında ters bir korelasyon saptandı, ancak bu korelasyon postoperatif 18. ayda izlenmedi.

Sonuç: Serimize göre pilorun 4 cm distalinden transeksiyonla yapılan LSG mide boşalmasını etkilemekte ancak kilo kaybı ile anlamlı bir korelasyon göstermemektedir.

Anahtar kelimeler: Mide boşalma sintigrafisi, Mide hacmi, Kilo kaybı, Tüp mide ameliyatı, Morbid obezite

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Introduction

Gastric emptying (GE) of liquid food is directed by the gastric tone of the fundus (regulated by vagal and hormonal stimulation), while the propulsive contractions of the antrum are the primary mechanism for gastric emptying of solid food. Normal GE requires intact antropyloric coordination. Such coordination can be modified depending on whether a greater or lesser antral resection was performed, as in the case of sleeve gastrectomy (SG) [1].

Intragastric pressure is yet another mechanism that may justify alterations in GE, which in this surgery is significantly higher, reaching values of 40 mmHg, while an intact stomach produces approximately 19 mmHg (11-26 mmHg) of pressure [2]. Thus, increased intragastric pressure leads to reduced gastric distensibility, which in turn promotes accelerated GE in a resected antrum and may even lead to dumping syndrome [2].

Therefore, the mechanisms that may be involved in altering GE after a SG are [3] include functional anatomical modification, reduction of the gastric reservoir, alteration of the gastric pacemaker and interdigestive motility, alteration of antropyloric coordination and alteration of the neurohormonal mechanism. Published studies on GE of solid food after restrictive surgeries yield contradictory results. Some show accelerated emptying [4,5] and others, no notable change [6]. The objective of this prospective study is to analyze the changes in gastric emptying following LSG produces and the correlation between gastric emptying and weight loss after surgery.

Materials and methods

Inclusion and exclusion criteria

This was a quasi-experimental study utilizing a within-subject design, evaluating the pre- and post-intervention (at 1 month and 18 months) parameters in a 52-patient sample with morbid obesity (MO) who met the National Institute of Health's (NIH) criteria [7] to undergo LSG surgery at the University General Hospital of Valencia-Spain between January 2016 and June 2019.

Anthropometric data were gathered at all stages of the study. Comorbidities and their progression, weight loss by means of the percentage of excess weight lost (%EWL) and the percentage of excess BMI lost (%EBMIL) [8], barium swallow, volume calculation and gastric emptying scintigraphy results were noted.

The Ethical Committee of the hospital approved the study, and informed consent was obtained from all patients.

Surgical technique

LSG surgery is performed with a standardized technique by four surgeons from the same facility. A 36 Fr bougie was employed to configure the gastric tract, initiating the transection 4 cm from the pylorus until the angle of His with an endo linear stapler and no reinforcement.

The 30-day surgical complications were noted according to the Clavien-Dindo surgical classification [9].

Gastric emptying scintigraphy

Radioisotope Tc^{99m} sulfur colloid was utilized and mixed with solid food. All medications that may affect gastric motility was withheld 2 days prior to the procedure. Diabetic patients arrived with their blood glucose correctly controlled. The meal consisted of a 120 g plain omelet, 20 g of wholewheat toast and 25 g single-dose strawberry jam. This meal contained 255 Kcal (72% carbohydrates, 24% protein, 2% fat and 2% fiber). Images were obtained by means of a gamma camera with a high resolution and low energy collimator (Philips Nuclear Medicine).

The study is conducted in the morning following 8 hours of fasting, with food intake lasting 10 minutes. Static images are obtained immediately after ingestion in a standing position with an anterior and posterior projection and image acquisition at 0, 30, 60, 120, 180 and 240 minutes. All patients completed the study within 6 hours (Figures 1 and 2).

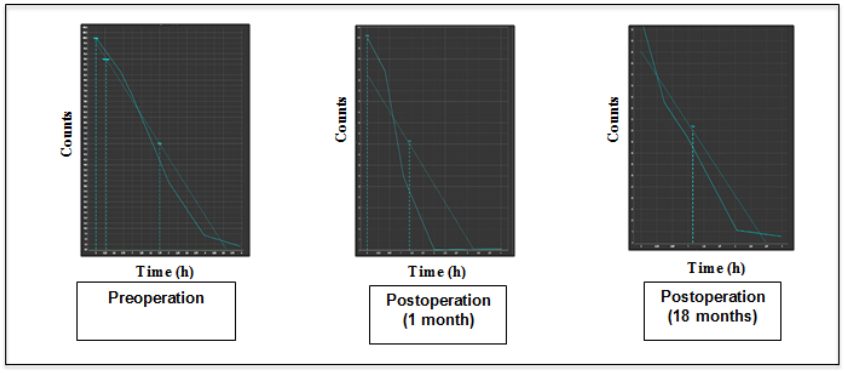

Figure 1: Indicative pre- and postoperative (1 month and 18 months) gastric emptying curves in a single patient

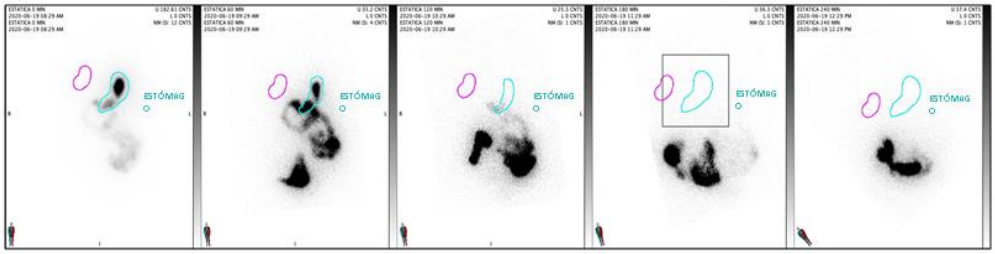

Figure 2: Anterior static images of a single patient at 0, 60, 120, 180 and 240 minutes after consumption of radiolabeled meal, demonstrating accelerated gastric emptying

Variables included:

Half time gastric emptying ($T_{½}$): Time (minutes) needed for the stomach to empty 50% of its contents into the duodenum.

Percentage of retention at 2 hours.

Percentage of retention at 4 hours.

Gastric emptying speed was classified as normal, delayed, or accelerated according to the percentage of retention ≤60% in 2 hours; >60% in 2 hours or <30% in one hour, respectively.

Barium swallow

The gastric volume was evaluated by means of barium swallow examinations. Volume estimations were performed in anterior-posterior and 90º lateral projections by the same radiologist according to a previously described technique [10] using geometric formulas for the gastric body (cylinder) and for the antrum (truncated cone).

Statistical analysis

The program used for statistical study was SPSS Statistics v.22 for Windows. It calculated the mean and its standard deviation and the median with the interquartile range if it did not adhere to a normal distribution. The statistical analysis was carried out applying McNemar's test for qualitative variables and Student's *t*-test for the comparison of means in paired quantitative variables. Pearson´s correlation test was used to test for correlations between variables. Results were statistically significant when $P<0.05$.

Results

Fifty-two patients (64.4% women and 34.6% men) with a median age of 46 years (25-63 years) were included in the study. One month after the intervention, 43/52 patients (82.7%) completed the study and at 18 months, 42/52 patients (80.8%) completed the study. A total of 42 patients completed the study. Ten patients were lost to follow-up: 6 patients dropped out of the study and 4 patients left due to post-operative complications.

There were 6 cases of postoperative complications, all of which were major (GIIIB) (wound dehiscence and hemoperitoneum, and 1 case of late complication (stenosis of the gastroplasty that required conversion to by-pass at 12 months postoperatively). No deaths were reported.

Tables 1 and 2 show the progression of anthropometric data and comorbidities in the different stages of the study.

Gastric emptying scintigraphy

Most of the patients in our series (71.1%) exhibit normal emptying in the preoperative study. Postoperatively, a significant increase in accelerated gastric emptying occurs at 1 and 18 months (40% and 35.7%, respectively) (Table 3 and 4).

There was a tendency for an inverse correlation between GE (percentage of retention at 2 hours) and the weight loss data (%EWL, %EBMIL) at 1 month (r =-2.37, p = 0.116; r = - 2.38, P=0.116, respectively), which did not remain at 18 months (r = 0.02, P=0.898; r = 0.043, P=0.788) (Figure 3).

Barium swallow

The following table shows the results of gastric volume calculated preoperatively, at 1 month and at 18 months (Table 5). There was no correlation between GE (percentage of retention at 2 hours) and the gastric volume at 1 month (r =-0.72 p = 0.639) and at 18 months (r = 0.95 P=0.551).

Table 1: Anthropometric characteristics of the subjects

Characteristic	PRE	1M	18M	*P*-value
BMI (kg/m^2)	45 (5.6)	37.9 (5.8)	29.4 (5.2)	<0.05
Waist circumference (cm)	125 (12)	114.2 (11.5)	98.3 (13.4)	<0.05
%EBMIL (%)	-	36.9 (17.2)	77.6 (25)	<0.05
%EWL (%)	-	32.2 (14.7)	67.6 (21.2)	<0.05

Values are expressed as mean and its standard deviation, BMI: body mass index; %EWL: percentage of excess weight lost; %EBMIL: percentage of excess BMI lost

Table 2: Obesity-related comorbidities

Comorbidities	PRE n (%)	1M Outcome	n	%	18M Outcome	n	%
HTA	16 (38.1%)	Remission	0	0	Remission	6	37.5
		Improvement	10	62.5	Improvement	6	37.5
		Unchanged	6	37.5	Unchanged	4	25
		Total	16	100	Total	16	100
DM	10 (23.8%)	Remission	0	0	Remission	6	60
		Improvement	8	80	Improvement	4	40
		Unchanged	2	20	Unchanged	0	0
		Recurrence	0	0	Recurrence	0	0
		Total	10	100	Total	10	100
DL	14 (33.3%)	Remission	0	0	Remission	7	50
		Improvement	6	42.8	Improvement	4	28.5
		Unchanged	8	57.2	Unchanged	3	23.1
		Total	14	100	Total	14	21.4
OSA	19 (45.2%)	Remission	3	14.3	Remission	12	63.2
		Improvement	3	19	Improvement	5	26.3
		Unchanged	13	66.7	Unchanged	2	10.5
		Total	19	100	Total	19	100

HTA: Hypertension, DM: Diabetes mellitus, DL: dyslipidemia, OSA: Obstructive sleep apnea

Table 3: Gastric emptying speed pre- and postoperatively (1 and 18 months)

Characteristic	PRE		1M		18M		*P*-value
	n	%	n	%	n	%	
Gastric Emptying							<0.05
Accelerated	8	15.4	18	40	15	35.7	
Delayed	7	13.5	3	6.6	3	7.1	
Normal	37	71.1	24	53.4	24	57.2	
Total	52	100	45	100	42	100	

Table 4: Gastric emptying pre- and postoperatively (1 and 18 months)

Characteristic	PRE	1M	18M	*P*-value
TG ½ (min)	101.1 (44)	88.6 (51.5)	80.7 (53)	< 0.05 *
Percentage of retention 2 h (%)	33.4 (17.4)	26.1 (18.5)	28.6 (15.2)	< 0.05 +
Percentage of retention 4 h (%)	5.8 (18.3)	4.5 (16.2)	2.8 (12.6)	NS

Values are expressed as mean and its standard deviation, TG ½: 50% gastric emptying, * PRE-1M y PRE-18M; + PRE-1M

Table 5: Gastric volume pre- and postoperatively (1 and 18 months)

Characteristic	PRE	1M	18M	*P*-value
Gastric volume (ml)	1812 (517.24)	239.5 (88.7)	280.8 (100.6)	<0.05
Percentage of reduced volume 1M (%)	-	85.6 (6.95)	-	
Percentage of increased volume 18M (%)	-	-	18.98 (23.15)	
n	52	49	42	

Values are expressed as mean and its standard deviation

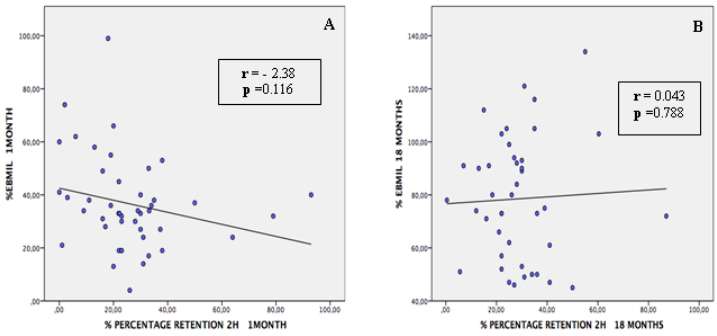

Figure 3: Correlation between gastric emptying and weight loss at 1 month and 18 months (A: %EBMIL and Percentage of retention 2h at 1 month, B: %EBMIL and Percentage of retention at 2h at 18 months)

Discussion

After SG, the gastric reservoir function becomes substantially reduced due to the removal of gastric relaxation or food accommodation capacity after resection. Consequently, alterations in gastric emptying can be observed [1].

Most of the patients in our series presented a normal preoperative isotope gastric emptying test and, although more

than half of the patients showed normal gastric emptying after the SG, a significant increase in accelerated gastric emptying was evident (40% at one month and 35.7% at 18 months) with respect to the preoperative (15.4%) status.

The effect of SG on obesity is based on three pillars of action: The restrictive effect, the hormonal effect, and alteration in gastric motility. The first two mechanisms have been widely researched with solid scientific evidence since the works published by Gagner [11,12], while the final mechanism is more complex and could be related to gastric emptying [13].

In fact, several mechanisms may be implicated in the alteration of gastric emptying after SG [2,3,6,13]. One of them is the reduced gastric volume that leads to an increase in intragastric pressure and consequently, reduced gastric wall distensibility [2]. The present study did not find any significant correlation between the 2-hour or the 4-hour retention rates and gastric volume. Another factor is an antropyloric coordination altered by antral resection. This may justify the dissimilar results published in the scientific literature whereby some authors present no alteration in gastric emptying after SG [6] with a transection at 6 cm from the pylorus and using a 48Fr bougie, while other authors show accelerated gastric emptying after SG with a transection at 5 cm from the pylorus and using a 34Fr bougie [4,5]. For this study, the technique was systematized, maintaining a distance of 4 cm from the pylorus using a 36Fr bougie, and was always conducted by the same surgical team. These data are more in line with studies that observe accelerated post-operative gastric emptying.

The implication of gastric emptying in morbid obesity also remains unclear. Accelerated gastric emptying may lead to poor satiety and increased intake, which would lead to an increase in BMI [14]. On the other hand, some studies do not find significant differences between gastric emptying in standard weight and obese patients [15]. Consequently, no conclusive data exist to include accelerated gastric emptying as a factor involved in weight loss after LSG. No significant correlation between BMI and the percentage of retention in gastric emptying was found, in line with Berstine's study [6].

Limitations

Our study has limitations, including the small sample size and short follow-up, for which a good validation of results is necessary over time.

Conclusions

The current study proves that LSG causes a significant increase in accelerated gastric emptying in the postoperative period. However, these results have no effect on weight loss.

Large scale studies are needed to evaluate the effect of LSG on gastric emptying to either confirm or refute its involvement as a mechanism of action in post-LSG weight loss.

References

1. 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(11):1515-21. doi: 10.1007/s11695-009-9954-z
2. 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(9):1083-8. doi 10.1007/s11695-008-9576-x
3. Popescu A-L, Ioniță-Radu F, Jinga M, Gavrilă A-I, Săvulescu F-A, Fierbințeanu-Braticevici C. Laparoscopic sleeve gastrectomy and gastroesophageal reflux. Rom J Intern Med. 2018;56(4):227-32. doi 10.1007/s11695-007-9006-5
4. Melissas J, Koukouraki S, Askoxylakis J, Stathaki M, Daskalakis M, Perisinakis K, et al. Sleeve Gastrectomy — A Restrictive Procedure? Obes Surg. 2007;17(1):57-62.
5. Melissas J, Leventi A, Klinaki I, Perisinakis K, Koukouraki S, de Bree E, et al. Alterations of Global Gastrointestinal Motility After Sleeve Gastrectomy: A Prospective Study. Ann Surg. 2013;258(6):976-82. doi 10.1007/s11695-008-9791-5
6. Bernstine H, Tzioni-Yehoshua R, Groshar D, Beglaibter N, Shikora S, Rosenthal RJ, et al. 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(3):293-8.
7. Hubbard VS, Hall WH. Gastrointestinal Surgery for Severe Obesity. Obes Surg. 1991 Sep;1(3):257-265. doi: 10.1381/096089291765560962.
8. Sabench Pereferrer F, Domínguez-Adame Lanuza E, Ibarzabal A, Socas Macias M, Valentí Azcárate V, García Ruiz de Gordejuela A, et al. Criterios de calidad en cirugía bariátrica: revisión de conjunto y recomendaciones de la Asociación Española de Cirujanos y de la Sociedad Española de Cirugía de la Obesidad. Cir Esp. 2017;95(1):4-16. doi10.1016/j.ciresp.2016.09.007
9. Dindo D, Demartines N, Clavien P-A. Classification of Surgical Complications: A New Proposal With Evaluation in a Cohort of 6336 Patients and Results of a Survey. Ann Surg. 2004;240(2):205-13. doi: 10.1097/01.sla.0000133083.54934.ae.
10. Grifo I, Bruna M, Puche J, Jareño S, Navarro C, Gómez R, et al. Gastrectomia vertical: importancia del volumen gástrico resecado. BMI-journal .2017;7(1):1304-8
11. Gumbs AA, Gagner M, Dakin G, Pomp A. Sleeve Gastrectomy for Morbid Obesity. Obes Surg. 2007;17(7):962-9. doi:10.1007/s11695-007-9151-x
12. Gagner M. Faster Gastric Emptying after Laparoscopic Sleeve Gastrectomy. Obes Surg. 2010;20(7):964-5. doi:10.1007/s11695-010-0086-2
13. Pilone V, Tramontano S, Micco RD, Monda A, Hasani A, Izzo G, et al. Gastric emptying after sleeve gastrectomy: statistical evidence of a controlled prospective study with gastric scintigraphy. Minerva Chir. 2013;68(4):9. PMID: 24019046.
14. Cardoso-Júnior A, Gonzaga Vaz Coelho L, Savassi-Rocha PR, Vignolo MC, Abrantes MM, Miranda de Almeida A, et al. Gastric Emptying of Solids and Semi-solids in Morbidly Obese and Non-obese Subjects: An Assessment Using the 13C-Octanoic Acid and 13C-Acetic Acid Breath Tests. Obes Surg. 2007;17(2):236-41. doi:10.1007/s11695-007-9031-4
15. Verdich C, Lysgård Madsen J, Toubro S, Buemann B, Holst J, Astrup A. Effect of obesity and major weight reduction on gastric emptying. Int J Obes. 2000;24(7):899-905. doi: 10.1038/sj.ijo.0801250.

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