Is Sleeve gastrectomy a refluxing procedure? Prospective study using Radionucleotide Scintigraphy

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ABSTRACT

Introduction: *Obesity is a worldwide epidemic disease that plays a role in development of Gastro-esophageal reflux disease (GERD). Increasing body mass index plays a role in incompetence of gastro-esophageal junction. Weight loss and life style modifications reduce the symptoms of GERD. The effect of Sleeve gastrectomy on GERD is not well described.* ***Aim of work:*** *The purpose of this study is to assess the relationship between Laparoscopic Sleeve Gastrectomy (LSG) and GERD.* ***Patients and Methods:*** *The study included 40 morbidly obese patients who were assessed for GERD by radionuclide scintigraphy and validated questionnaire for GERD symptoms preoperatively, then 6 and 12 months after LSG.* ***Results:****GERD symptoms resolved in 50% of the patients who were symptomatic preoperatively. 25% of asymptomatic patients developed new GERD symptoms post LSG. There was no significant correlation between BMI changes and development or improvement of symptoms of GERD in the first year post-operatively.* ***Conclusion:*** *LSG can be safely done for morbidly obese patients experiencing preoperative GERD.*

Keywords: *Laparoscopic sleeve gastrectomy - Gastroesophageal reflux disease Radionucleotide Scintigraphy.*

INTRODUCTION

Obesity is an epidemic prevalent all over the world, and obesity rates are increasing around the world. The latest estimates are that approximately 34% of adults and 15–20% of children and adolescents are obese. Obesity affects every segment of the population and increases the risk of many chronic diseases in children and adults Because of the complexity of obesity, it is likely to be one of the most difficult public health issues society has faced [1].

Treatment options of obesity, except surgery, are generally ineffective in long-term weight control. [2,3]. In addition to sustained weight loss, surgical treatment provides additional benefits to people with obesity-related comorbidities and reduces relative risk of death due to significant weight loss. [4 , 5]

Prevalence of obesity and gastroesophageal reflux disease (GERD) have paralleled one another over the past decade, which suggests the possibility of a linkage between these two processes. In both instances, surgical therapy is recognized as the most effective treatment for severe, refractory disease.

The effect of LSG on GERD remains controversial as relationship between them is complex and no clear relationship exists [6].

Scintigraphic techniques for evaluating esophageal function were initially developed by Kazem in 1972 and since that time have been applied to a variety of pathophysiologic states [7]. Radionuclide Scintigraphy enables gastroesophageal reflux to be physiologically observed non-invasively using a gamma camera and Tc-99m labeled diethylene triamine pentaacetate (DTPA). The risk from radiation exposure is minimal and this method does not require hospitalization.

Apart from detecting gastroesophageal reflux, it allows for evaluation of esophageal motility and stomach emptying, and sometimes also visualization of aspiration of the gastric content to the respiratory tract.

Aim of work

The purpose of this study is to assess the relationship between Laparoscopic Sleeve Gastrectomy (LSG) and GERD.

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PATIENTS AND METHODS

This prospective study included 40 consecutive patients over 6 months' period. All patients underwent a LSG as a primary one-stage bariatric procedure by a team of surgeons using the same surgical technique in Cairo University Hospitals.

Preoperative evaluation followed the same standard protocol and included thorough history, complete endocrinal workup, psychological evaluation, and counseling by a dietician. All patients underwent upper abdominal ultrasonography to look specifically for gallstones.

The subjects were considered appropriate candidates for the present study if they were aged between 18–65 years, with BMIs of ≥40kg/m2, or between 35kg/m2 and 40kg/m2 with obesity related disease.

Informed written consent was obtained from all patients. Patients willing to participate in our study consented to fill a questionnaire (Reflux Symptom Index Questionnaire) **(Table 1)** and undergo a Scan for assessment of Gastro-esophageal reflux (RadioNuclide Scintigraphy) preoperatively. Patients consented as well to refill same questionnaire and have a repeat scan at 6 and 12-month post operatively.

Table 1: Reflux Symptom Index (RSI) Questionnaire

Within the last MONTH, how did the following problems affect you?	0 = No Problem 5 = Severe Problem					
1. Hoarseness or a problem with your voice	0	1	2	3	4	5
2. Clearing your throat	0	1	2	3	4	5
3.Excess throat mucous or postnasal drip	0	1	2	3	4	5
4. Difficulty swallowing food, liquids, or pills	0	1	2	3	4	5
5.Coughing after you ate or after lying down	0	1	2	3	4	5
6. Breathing difficulties or choking episodes	0	1	2	3	4	5
7. Troublesome or annoying cough	0	1	2	3	4	5
8. Sensation of something sticking in your throat or a lump in your throat	0	1	2	3	4	5
9. Heartburn, chest pain, indigestion or stomach acid coming up	0	1	2	3	4	5
	TOTAL					
The Reflux Symptom Index A score > 10 may indicate significant reflux A score > 13 definitely abnormal						

Radionuclide Scintigraphy :

a. Scintigraphic Evaluation of Esophageal Transit

All patients (in sitting position) were given 15 ml water containing 0.5 mCi (18.5MBq) of Tc-99m labeled DTPA. Patients were instructed to hold the mouthful of the prepared water in their mouth for a few seconds and then swallow it when the examiner give a sign. During the study, 20 transit images were recorded at 0.5 s intervals. Regions of interests (ROIs) were outlined on the esophagus and then the time-activity curves (TACs) were created. From these TACs, esophageal transit time was calculated using a software program. The observation of the peak activity on the TACs within 10 s was accepted as normal esophageal clearance.

b. Scintigraphic Evaluation of Gastro-esophageal Reflux

Patients were then given additional water to washout oropharyngeal and esophageal residual activity. After this, they were re-positioned supine under the gamma camera equipped with an all-purpose, low-energy, parallel hole collimator covering an NaI (Tl) crystal of 3/8 inch thickness, set at 140keV, with a 20% window, zoom 1.0. Dynamic imaging was performed in 64x64 matrix with 60-s frames for 30 min. Time-activity curves

(TACs) were derived from regions of interests (ROIs) drawn over the esophagus and stomach. TACs were analyzed and additionally all images were visually evaluated. Detection of the activity in the esophagus on the images visually or detection of one or more peaks on TACs at any time during the scintigraphic evaluation was considered as gastro-esophageal reflux. Peaks which displayed a two-fold or more increment in the esophageal curves over the baseline were accepted as reflux episode.

Surgical procedure:

All procedures were performed under general anaesthesia with the patient in supine position and the surgeon positioned between the legs of the patient (French position) after applying compression stockings on the patient lower legs. The patients were firmly secured to the operating table to allow for placement in the anti-Trendelenburg position as required.

We use a 5-port technique. Greater curvature is devascularized proximally (exposing the left crus) and distally (3-4 cm proximal to the pyloric ring). Neostomach is fashioned over a 36Fr Bougie. Angle of His is minimally disturbed by applying the last stapler cartridge to the left at least 1 cm away from gastro-esophageal junction to preserve its anatomical and physiological function. We start stapling 4-6 cm from the pylorus aiming to make the sleeve more compliant. We believe that this leads to less postoperative vomiting in the immediate postoperative period. In addition, we believe this may as well decrease intragastric pressure and decrease chances of reflux post LSG.

We routinely invert staple line and perform methylene blue test. All surgical specimens were sent for histopathology to confirm absence of any esophageal tissue.

Patients have a gastrograffin meal on Day 1 post operative before they are allowed oral intake. They get discharged either at the end of Day 1 or Day 2 post operative on Proton pump inhibitors with written instructions regarding diet and supplements.

Statistical Methods

Data were statistically described in terms of mean and standard deviation (SD), median and range, or frequencies (number of cases) and percentages when appropriate. Comparison of numerical variables between the study groups was done using Student t test for independent samples. Within group comparison of numerical variables was done using paired t test. Multiple comparison between subgroups was performed using Turkey's test. For comparing categorical data, chi-square test was performed. Exact test was used instead when the expected frequency is less than 5. p values less than 0.05 was considered statistically significant. All statistical calculations were done using computer programs SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) version 18 for Microsoft Windows.

RESULTS

This prospective study included 40 morbidly obese patients with female predominance in the form of 36 females (90%) and 4 males (10%). The age ranged from 23 to 43 years with mean age 32.5±5.5 years. The mean BMI preoperative was 48.25±7.25 kg/m2 (range 38-65) **(Table 2).**

Table 2: Demographic data of the patients in the study group.

	Mean	Standard Deviation	Median	Minimum	Maximum
Age	32.50	5.50	34.50	23.00	43.00
Weight	128.40	24.04	124.50	100.00	185.00
Height	162.35	5.70	162.00	150.00	174.00
BMI(pre)	48.25	7.25	48.50	38.00	65.00

Ten patients (25%) had no associated co-morbidities. **Table 3** summarizes the associated co-morbidities among the studied group of patients.

Among the 40 morbidly obese patients that were included in the study 32 patients (80%) were diagnosed not having GERD based on the symptoms (RSI) and the scintigraphic scan while 8 patients (20%) were diagnosed as having GERD

All patients showed uneventful postoperative course and were discharged after 24-48 hour.

No esophageal tissue was found in any of the specimens sent for histopathology indicating that gastro-esophageal junction was not involved in the resected part.

In general, the mean postoperative BMI after 6 months was 42.15±6.72 kg/m2.After one year the mean postoperative BMI was 34.15±4.42 kg/m2.

Table 3: Comorbidities in patients included in the study group

		Count	%
Co-morbidities	Diabetes Mellitus	9	(22.5%)
	Hypertension	20	50.0%
	Mitral valve prolapse	1	2.5%
	NO	10	25.0%

Through the duration of one year BMI showed steady decline in all patients but the patients with pre-operative GERD showed more decline in BMI. **(Figure 1)**

Patients of each group were scanned Six months and one year post-operatively and RSI was calculated for each patient. Among the two groups, significant changes in the scintigraphic scan and RSI were encountered. Four patients (50%) that were having reflux pre-operatively improved (Negative scintigraphic scan and marked decline in RSI below 10 as shown in **figure 2 and Table 4**) while the other 4 patients (50%) remained having GERD (Positive scintigraphic scan and steady RSI figures above 10 as shown in **figure 3 and Table5**). On the other hand, of the 32 patients that had no GERD, 8 patients showed denovo GERD (25%) (Positive scintigraphic scan and marked rise in RSI above 10 as shown in **figure 4 and Table 6**)while the remainder showed no GERD (75%) (Negative scintigraphic scan and steady RSI figures below 10). **Table 7,8&9** summarize changes in the scintigraphic scan and RSI post-operatively.

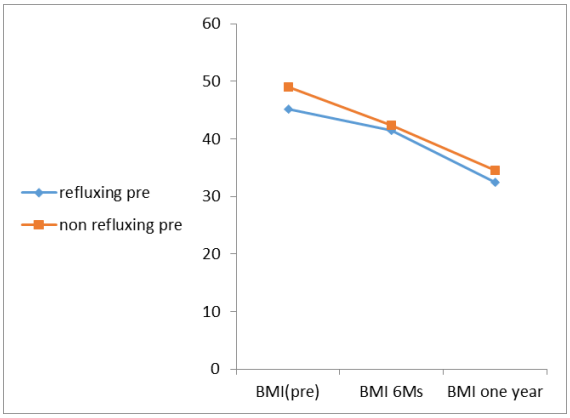

Fig. 1: Comparison between BMI changes in GERD and non-GERD patients in one year

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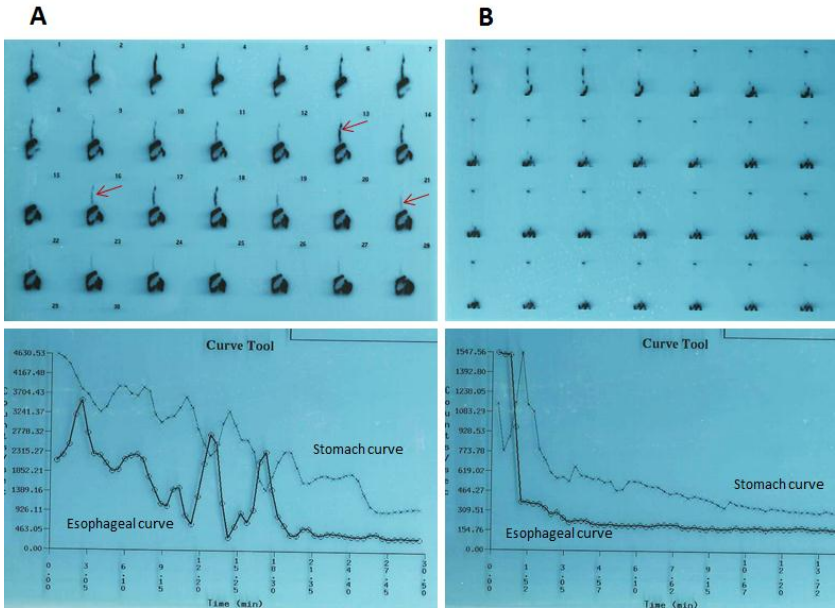

Fig. 2: Pre-operative (A) scan shows positive findings for GER in the form of tracer uptake in the esophagus in dynamic images (arrows) with evident upwards deflection in the esophageal curve with several peaks and corresponding downwards deflection of the stomach curve denoting GER of the tracer from stomach to esophagus. Post-operative (B) scan shows negative scan for GER. RSI.

Table 4: Clinical and scan quantitative indices in patient with scans in Figure 2

Parameter	***BMI (kg/m^2)***	***RSI***
Preoperative	***46***	***12***
Postoperative (one year)	***31***	***3***

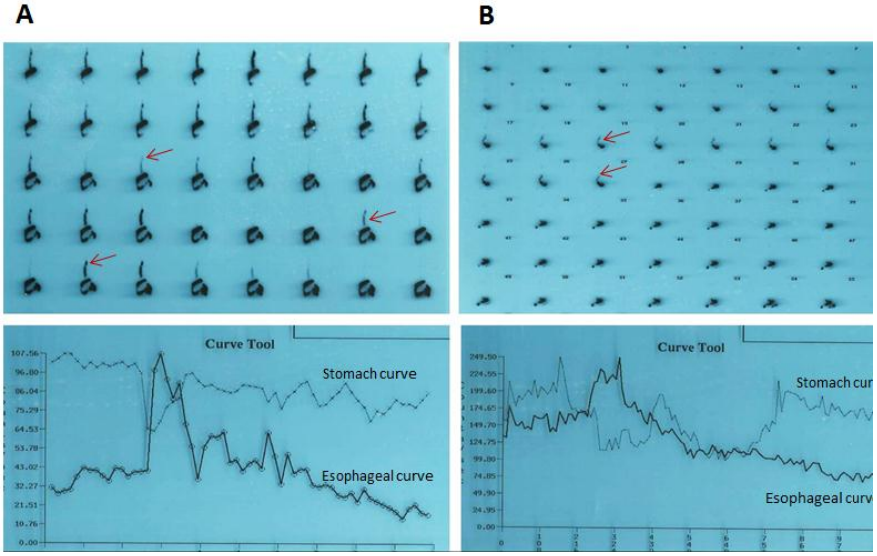

Fig. 3: pre-operative (A) and post-operative (B) scans show positive findings for GER in the form of tracer uptake in the esophagus in dynamic images (arrows) with evident upwards deflection in the esophageal curve with several peaks and corresponding downwards deflection of the stomach curve denoting GER of the tracer from stomach to esophagus.

Table 5: Clinical and scan quantitative indices in a patient in patient with scans in Figure 3

Parameter	***BMI (kg/m^2)***	***RSI***
Preoperative	***51.0***	***10.0***
Postoperative (one year)	***36.0***	***18.0***

Table 7: Changes in Radionucleotide Scintigraphy 6 months and one year post-operatively

		Count	**Column N %**
Pre-operative GERD patients	Improved	4	50.0%
	Remained having GERD	4	50.0%
GERD free patients	Remained free	24	75.0%
	Denovo reflux	8	25.0%

Table 8: Changes in RSI 6 months and one year post-operatively in patients with previously positive scan.

	Patients with previously positive scan										**P value**
	Negative post-operative scan					**Still positive post-operative scan**					
	Mean	SD	Median	Mini.	Maxi.	Mean	SD	Median	Mini.	Maxi.	
RSI (pre)	12.00	.00	12.00	12.00	12.00	10.50	.58	10.50	10.00	11.00	.029
RSI(Post 6 Ms)	1.50	1.73	1.50	.00	3.00	18.00	.00	18.00	18.00	18.00	.029
RSI (Post One year)	2.00	1.15	2.00	1.00	3.00	18.00	.00	18.00	18.00	18.00	.029

Table 9: Changes in RSI 6 months and one year post-operatively in patients with previously negative scan.

	Patients with previously negative scan.										**P value**
	no reflux					**denovo reflux**					
	Mean	SD	Median	Mini.	Maxi.	Mean	SD	Median	Mini.	Maxi.	
RSI (pre)	3.67	2.33	4.00	.00	7.00	4.00	1.85	3.00	3.00	7.00	.749
RSI (Post 6 Ms)	1.42	1.53	1.50	.00	5.00	15.25	4.10	15.00	11.00	20.00	.000
RSI (Post One year)	1.42	1.53	1.50	.00	5.00	15.75	3.58	15.50	12.00	20.00	.000

Pre-operative Pearson's correlation between BMI with RSI and the quantitative indices of the scan showed non-significant correlation in both the GERD negative (N=32) and GERD-positive (N=8) groups of patients which was still non-significant in the first one year post-operatively.

Lastly, among the whole group of patients post-sleeve gastrectomy, Chi-Square Pearson correlation analysis showed a high significant association between positivity of the scan for GER and RSI ($p<0.001$).

DISCUSSION

Several factors might contribute to the increased gastroesophageal gradient seen with obesity, including increased intra-abdominal pressure, increased intragastric pressure, increased negative inspiratory intrathoracic pressure, and a mechanical separation between the LES and the extrinsic compression provided by the diaphragmatic crura.[8]. Different bariatric procedures affect GERD quite variably. Best results have been reported with LRYGB **(Table 10).**

Table 10: Effect of bariatric surgery on gastroesophageal reflux disease [17

Study	Type of bariatric surgery	No. patients*	EWL	Type of assessment or study	Follow-up, mo	Results
Howard et al (2011)[18]	LSG	28	40	Upper GI swallow, clinical symptoms	8	18% new onset GERD GI series, 22% clinical GERD symptoms
Chiu et al (2009)[19]	LSG	15 studies	NA	Systematic review	NA	4 studies reported increase in prevalence, 7 studies reported reduction in prevalence
Woodman et al. (2012) [17]	LAGB	122	49.8	Quality of life questionnaire	24	80% resolution, 11% improvement, 7% no change, 2% worsening
de Jong et al. (2010) [20]	LAGB	3307	NA	Systematic review	NA	Reduction of reflux symptoms from 33.3% to 7.7%, 15% new onset reflux symptoms
Frezza et al (2002) [21]	LRYGB	152	64	Questionnaire of symptoms	12	Reduction of heartburn from 87% to 22%.
Perry et al. (2004) [22]	LRYGB	57	NA	Follow-up questionnaire	18	100% reported resolution or improvement of symptoms

LSG has rapidly gained a large consensus worldwide in the bariatric community because of its several advantages, which include it being a simple and straightforward surgical technique without needing an intestinal bypass or causing any digestive anastomosis. (9).

LSG may have different effects on GERD. Many theories about proposed mechanisms that how LSG can affect GERD. **(Table 11,12).**

Table 11: Proposed mechanisms for increase in prevalence of GERD symptoms after SG [23].

Proposed mechanisms for increased GERD after SG	Reference
Hypotension of the lower esophageal sphincter	Braghetto et al. [24]
Blunting of the angle of His	Himpens et al. [12]
Decreased gastric compliance and volume (leading to increased gastric pressure)	yehoshua et al. [25]
Decreased gastric emptying	Himpens et al. [12]
Decreased plasma ghrelin (dysmotility)	Nahata et al. [26]
Gastric sleeve shape	Lazoura et al. [27]
Increase in hiatal hernia	Baumann et al. [28]
Neofundus	Himpens et al. [16]

Table 12: Proposed mechanisms for decrease in prevalence of GERD symptoms after SG [23]

Proposed mechanisms for decreased GERD after SG	Reference
Accelerated gastric emptying	Melissas et al. [29], Shah et al. [30]
Decreased abdominal obesity	Pandolfino et al. [31]
Increased long-term gastric compliance	Karamanakos et al. [32]
Restoration of the angle of His Decreased acid production	Himpens et al. [12]
Gastric sleeve shape	Lazoura et al. [33]
Decreased wall tension	Santoro [34]

Studies available can be divided into two categories: those that demonstrate an increase in GERD prevalence after LSG **(Table 13)** and those that demonstrate a decrease in GERD prevalence after LSG **(Table 14).**

Table 13: Summary of studies showing increased GERD after sleeve gastrectomy [23, 35].

Study	Nature of study	Patients (n)	Evaluation of GERD	Follow-up (months)	Preoperative GERD (%)	Postoperative GERD (%)
Nocca et al, 2008	Prospective study	163	Symptom reporting	24	6.1% (n _= 10)	11.8%
Arias et al, 2009	Retrospective review	130	Symptom reporting	24	0	2.1% (n = 3)
Braghetto et al, 2010	Retrospective& literature review	167	Symptom reporting, pH monitoring, EM, EGD	Not reported	0	27.5% (n _= 46)
Lakdawala et al, 2010	Retrospective review	50	Symptom reporting, Medication usage	12	5%	9%
Himpens et al, 2010	Retrospective review	40	Medication usage	12, 36, and 72	20%	21.8% at 1 year, 3.1% at 3 years, 23% at 6 years
Carter et al, 2011	Retrospective review	176	Patient survey, Symptom reporting	24	34.6%	49% within 30 days 47.2% persisting > 1 month
Howard et al, 2011	Retrospective review	28	Symptom reporting, Medication usage, UGICS	8–92 weeks	25% (n _= 7)	39% (n _= 11)
Tai et al, 2012	Prospective study	67	Symptom reporting	12	12.1% (n = 8)	47%(n = 31, 5 persistent)
Sieber et al, 2014	Retrospective review	68	EGD, UGICS, EM	60	50%	Persistence : 44.1% De novo: 16%
Gorodner et al, 2014	Retrospective review	14	Symptom reporting, pH monitoring, UGICS, EGD, EM.	14	29% (n = 4)	64% (n = 9)
Burgerhart et al, 2014	Prospective study	20	Symptom reporting, pH monitoring, EM	3	70% (n _= 14) Acid exposure: 4.1%	Persistence:57% (n _= 8) No change: (14%) Worsening: (43%) De novo: 10% Acid exposure: 12%
Dupree et al, 2014	Retrospective review	4832	Symptom reporting	36	44.50%	Persistence: 84.1% De novo: 8.6%

GERD: Gastroesophageal reflux disease, **EGD**: Esophogastroduodenoscopy, **EM**: Esophageal manometry, **UGICS**: Upper gastrointestinal contrast study.

Table 14: Summary of studies showing reduced GERD after sleeve gastrectomy [23, 35].

Study	Nature of study	Patients (n)	Evaluation of GERD	Follow-up (months)	Preoperative GERD (%)	Postoperative GERD (%)
Weiner et al, 2007	Prospective study	120	Symptom reporting	60	35% (*n* _= 42)	15% (*n* _= 18)
Melissas et al,2007	Prospective study	23	Symptom reporting, Gastric emptying scintigraphy	12	35% (*n* = 8)	30% (*n* = 7, 2 new)
Melissas et al, 2008	Prospective study	14	Symptom reporting, Gastric emptying scintigraphy	6 - 24	14% (*n* _= 2)	35.7% (*n* _= 5) at 6 months 7% (*n* _= 1) at 24 months
Chopra et al, 2012	Retrospective review	174	Symptom reporting	6 - 36	13.7% (*n* = 24)	13.2% (*n* = 23, 6 new)
Rawlins et al, 2013	Retrospective study	49	Symptom reporting	60	30.6% (*n* _= 15)	26.5% (*n* _= 13, 7 persistent, 6 new)
Pallati et al, 2014	Prospective database	585	Symptom reporting, medication usage	6	All patients Included	Score improvement 41% Worsening: 4.6 % de novo: 9.2%
Del Genio et al, 2014	Prospective database, Retrospective analysis	25	HRiM, MII-pH	13	Patient excluded if preop. GERD	No de novo GERD
Daes et al, 2014	Prospective study	382	Symptom reporting, EGD	22	44.5%	2.6% 94% resolution of symptoms

GERD: Gastroesophageal reflux disease, **EGD**: Esophogastroduodenoscopy, **HRiM**: High-resolution impedance manometry, **MII-pH**: Combined 24-H pH multichannel intraluminal impedance

It is apparent that the relation between GERD and sleeve gastrectomy is affected by multiple factors. Moreover, the technique used by the operator is a major factor. Consequently, it is essential to perform a correctly fashioned sleeve to avoid inducing de novo GERD or augmenting already present preoperative GERD [10]. Several technical modifications have been proposed to minimize postoperative GERD as reported by Nassif et al [11].

In our study, we found that 50% of the patients with previous GERD showed marked symptomatic improvement (marked decline in the RSI below 10) and negative scintigraphic scan.

Daes et al. in their prospective evaluation of 382 showed a decrease in the prevalence of GERD after LSG from 44.5% to 2.6%. They also showed 94% resolution of GERD symptoms. They emphasized the need for careful attention to surgical technique, such as avoiding relative narrowing at the junction between the vertical and horizontal parts of the stomach, and the importance of placing the anterior stomach wall and posterior stomach wall in an equal and flat position when firing the stapler, in order to keep the sleeve from rolling and spiraling [12].

However, 25% of our patients with no previous GERD evident by low RSI (below 10) and negative scintigraphic scan developed de novo GERD postoperatively.

Braghetto et al [13] who excluded patients with GERD preoperatively and reported a 27.5% incidence of GERD after LSG. Sieber et al. performed a retrospective analysis of a prospective cohort with a minimal follow-up of 5 years. The study included 68 patients. GERD was evaluated by esophageal manometry, upper gastrointestinal contrast study and endoscopy. Fifty percent of the patients had preoperative GERD. Postoperatively, 44.1% of the patients had persistent GERD symptoms, while new-onset gastroesophageal reflux was detected in 11 patients (16.2%) [14].

We observed an increase in the mean esophageal transit time among these patients post LSG (Compared to preoperative scan). Esophageal transit time remained however within the normal range in these patients.

Ömür et al. using scintigraphic methods to evaluate alterations of gastric and esophageal functions agreed with our results and reported that the mean esophageal transit time was significantly longer in GERD positive obese patients (11.2±7.3 s) than GERD negative obese patients (8.2±7.2 s). [15].

Himpens et al. observed a decrease of GERD symptoms at 3 years after an initial increase. This was attributed to the Sleeve getting wider heightening gastric compliance and reducing the intragastric gradient pressure and, therefore, the gastroesophageal reflux [16].

Del Genio et al. reported that after SG, the narrow vertical gastrectomy causes a relevant reduction of the gastric compliance. Once the stomach gets full (e.g., 100–200 cc), the intraluminal pressure increases according to Laplace's law.

In this condition, part of the bolus impacts against the elevated gastric pressure and "bounces back" into the esophagus. This phenomenon due to an intraluminal stasis and not to de novo GERD produces an esophageal acidification, wrongly interpreted at standard pH monitoring as GERD. They concluded that a correctly fashioned sleeve does not affect LES. Retrograde movements and increased acid exposure are probably due to stasis and postprandial regurgitation [10].

Lastly, we observed high significant association between positivity of the scan for GER and RSI ($p<0.001$) indicating high sensitivity of radionuclide scintigraphy and its applicability to be used as one of the diagnostic methods of GERD.

Nevertheless, it may be helpful to add another tools for the study validating the findings of gastroesophageal reflux detected by radionuclide scintigraphy as upper GI endoscopy, pH-monitoring, impedance and esophageal monitoring. Longer follow up periods may be needed to detect the outcome of the patients. One other limitation to our study is the multiplicity of the operating surgeons while single operating surgeon may give more clear results

Summary

Obesity is a worldwide epidemic disease that is known to play a role in the development of gastro-esophageal reflux disease (GERD). Laparoscopic sleeve gastrectomy (LSG) has been shown to be an effective and efficient mean of achieving significant and sustainable weight loss in severely obese individuals. Therefore, it leads to the improvement of most of obesity related comorbidities. However, the effect of LSG on GERD remains controversial.

The purpose of this study is to assess the effect of LSG on morbidly obese patients with pre-operative GERD and to detect the development of de novo GERD postoperatively by radionuclide scintigraphy and symptom reporting.

The study included 40 morbidly obese patients that were assessed for GERD by radionuclide scintigraphy and validated questionnaire for GERD symptoms before and 6 and 12 months after LSG.

Our results demonstrated the resolution of GERD in half of the patients who experienced GERD preoperatively and persistence of GERD in the other half after LSG. They also demonstrated the development of de novo GERD in some patients postoperatively (25%).

The study also showed that there is no significant correlation between BMI changes and development or improvement of symptoms of GERD in the first year post-operatively.

Finally, the study showed applicability of radionuclide scintigraphy to be used as one of the diagnostic methods of GERD.

CONCLUSION

LSG being judged as a refluxing procedure should be revised by more studies. Studies should include pre and postoperative pH and manometric studies to clarify the causes of either improvement of old or development of new reflux.

Conflict of Interest:

Dr. Milad, ElHawary, Kandeel, Abougabal and Maurice, declare No conflict of interest.

REFERENCES

1. Nia Mitchell, Vicki Catenacci , Holly R. Wyatt, et al. Obesity: over view of an epidemic. Psychiatr Clin North Am. 2011 Dec; 34(4): 717–732.
2. Chauhan V, Vaid M, Gupta M, Kalanuria A, Parashar A. Metabolic, renal, and nutritional consequences of bariatric surgery: implications for the clinician. South Med J. 2010 Aug; 103(8):775–783.
3. Ochner CN, Gibson C, Carnell S, Dambkowski C, Geliebter A. The neurohormonal regulation of energy intake in relation to bariatric surgery for obesity. Physiol Behav. 2010 Jul 14; 100(5):549–559.
4. Marsk R, Naslund E, Freedman J, Tynelius P, Rasmussen F. Bariatric surgery reduces mortality in Swedish men. Br J Surg. 2010 Jun; 97(6):877–883.
5. Matarasso A, Roslin MS, Kurian M. Bariatric surgery: an overview of obesity surgery. Plast Reconstr Surg. 2007 Apr 1; 119(4):1357–1362.
6. Lalor PF, Tucker ON, Szomstein S, et al. Complications after laparoscopic sleeve gastrectomy J. Surg Obes Relat Dis. 2008;4:33–8.
7. Kazem I. A new scintigraphic technique for the study of the esophagus. AJR 1972; 115:682-688.
8. Vivek N Prachand and John C Alverdy. Gastroesophageal reflux disease and severe obesity: Fundoplication or bariatric surgery?. World J Gastroenterol. 2010 Aug 14; 16(30): 3757–3761.
9. Consten EC, Gagner M, Pomp A, et al. Decreased bleeding after laparoscopic sleeve gastrectomy with or without duodenal switch for morbid obesity using a stapled buttressed absorbable polymer membrane. Obes Surg. 2004; 14:1360–6.
10. Del Genio G, Tolone S, Limongelli P, Brusciano L, D'Alessandro A, Docimo G, Rossetti G, Silecchia G, Iannelli A, del Genio A, del Genio F, Docimo L. Sleeve gastrectomy and development of "de novo" gastroesophageal reflux. Obes Surg 2014; 24: 71-77.
11. Prachand VN, Ward M, Alverdy JC. Duodenal switch provides superior resolution of metabolic comorbidities independent of weight loss in the super-obese compared with gastric bypass. J Gastrointest Surg 2010; 14:211–20.
12. J. Himpens, G. Dapri, and G. B. Cadi`ere, "A prospective randomized study between laparoscopic gastric banding and laparoscopic isolated sleeve gastrectomy: results after 1 and 3 years," Obesity Surgery, vol. 16, no. 11, pp. 1450–1456, 2006.
13. Braghetto, A. Csendes, E. Lanzarini, K. Papapietro, C. C´arcamo, and J. C. Molina, "Is laparoscopic sleeve gastrectomy an acceptable primary bariatric procedure in obese patients? Early and 5-year postoperative results," Surgical Laparoscopy Endoscopy & Percutaneous Techniques, vol. 22, no. 6, pp. 479– 486, 2012.
14. Sieber P, Gass M, Kern B, Peters T, Slawik M, Peterli R. Five year results of laparoscopic sleeve gastrectomy. Surg Obes Relat Dis 2011; 10: 243-249.
15. Ömür et al. Scintigraphic methods to evaluate alterations of gastric and esophageal functions in female obesity. Molecular imaging and radionuclide therapy 2014; 23(1): 5-11.
16. J. Himpens, J. Dobbeleir, and G. Peeters, "Long-term results of laparoscopic sleeve gastrectomy for obesity," Annals of Surgery, vol. 252, no. 2, pp. 319–324, 2010.
17. Woodman G, Cywes R, Billy H, et al. Effect of adjustable gastric banding on changes in gastroesophageal reflux disease (GERD) and quality of life. Curr Med Res Opin. 2012; 28:581–9.
18. Howard DD, Caban AM, Cendan JC, et al. Gastroesophageal reflux after sleeve gastrectomy in morbidly obese patients. Surg Obes Relat Dis. 2011; 7:709–13.
19. Chiu S, Birch DW, Shi X, et al. Impact of sleeve gastrectomy on gastroesophageal reflux disease: a systematic review. Surg Obes Relat Dis. 2011; 7:510–5.
20. de Jong JR, Besselink MGH, Van Ramshorst B, et al. Effects of adjustable gastric banding on gastroesophageal reflux and esophageal motility: a systematic review. Obes Rev. 2010; 11:297–305.
21. Frezza EE, Ikramuddin S, Gourash W, et al. Symptomatic improvement in gastroesophageal reflux disease (GERD) following laparoscopic Roux-en-Y gastric

bypass. Surg Endosc. 2002; 16:1027–31.
22. Perry Y, Courcoulas AP, Fernando HC, et al. Laparoscopic Roux-en-Y gastric bypass for recalcitrant gastroesophageal reflux disease in morbidly obese patients. JSLS. 2004; 8:19–23.
23. Laffin M, Chau J, Gill RS, et al. Sleeve Gastrectomy and Gastroesophageal Reflux Disease, Journal of Obesity Volume 2013, Article ID 741097, 6 pages.
24. Braghetto, E. Lanzarini, O. Korn, H. Valladares, J. C. Molina, and A. Henriquez, "Manometric changes of the lower esophageal sphincter after sleeve gastrectomy in obese patients," Obesity Surgery, vol. 20, no. 3, pp. 357–362, 2010.
25. R. T. Yehoshua, L. A. Eidelman, M. Stein et al., "Laparoscopic Sleeve gastrectomy—volume and pressure assessment," Obesity Surgery, vol. 18, no. 9, pp. 1083–1088, 2008.
26. M. Nahata, S. Muto, N. Oridate et al., "Impaired ghrelin signaling is associated with gastrointestinal dysmotility in rats with gastroesophageal reflux disease," American Journal of Physiology-Gastrointestinal and Liver Physiology, vol. 303, no. 1, pp. G42–G53, 2012.
27. O. Lazoura, D. Zacharoulis, G. Triantafyllidis et al., "Symptoms of gastroesophageal reflux following laparoscopic sleeve gastrectomy are related to the final shape of the sleeve as depicted by radiology," Obesity Surgery, vol. 21, no. 3, pp. 295–299, 2011.
28. T. Baumann, J. Grueneberger, G. Pache et al., "Three-dimensional stomach analysis with computed tomography after laparoscopic sleeve gastrectomy: sleeve dilation and thoracic migration," Surgical Endoscopy and Other Interventional Techniques, vol. 25, no. 7, pp. 2323–2329, 2011.
29. J. Melissas, A. Leventi, I. Klinaki et al., "Alterations of global gastrointestinal motility after sleeve gastrectomy," Annals of Surgery, 2012
30. S. Shah, P. Shah, J. Todkar, M. Gagner, S. Sonar, and S. Solav, "Prospective controlled study of effect of laparoscopic sleeve gastrectomy on small bowel transit time and gastric emptying half-time in morbidly obese patients with type 2 diabetes mellitus," Surgery for Obesity and Related Diseases, vol. 6, no. 2, pp. 152–157, 2010.
31. J. E. Pandolfino, H. Kim, S. K. Ghosh, J. O. Clarke, Q. Zhang, and P. J. Kahrilas, "High-resolution manometry of the EGJ: an analysis of crural diaphragm function in GERD," American Journal of Gastroenterology, vol. 102, no. 5, pp. 1056–1063, 2007.
32. S. N. Karamanakos, K. Vagenas, F. Kalfarentzos, and T. K. Alexandrides, "Weight loss, appetite suppression, and changes in fasting and postprandial ghrelin and peptide-YY levels after Roux-en-Y gastric bypass and sleeve gastrectomy: a prospective, double blind study," Annals of surgery, vol. 247, no. 3, pp. 401–407, 2008.
33. O. Lazoura, D. Zacharoulis, G. Triantafyllidis et al., "Symptoms of gastroesophageal reflux following laparoscopic sleeve gastrectomy are related to the final shape of the sleeve as depicted by radiology," Obesity Surgery, vol. 21, no. 3, pp. 295–299, 2011.
34. S. Santoro, "Technical aspects in sleeve gastrectomy," Obesity Surgery, vol. 17, no. 11, pp. 1534–1535, 2007.
35. Stenard F, Iannelli A. Laparoscopic sleeve gastrectomy and gastroesophageal reflux. World J Gastroenterol 2015; 21(36): 10348-10357.