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Comparison of comorbidity resolution and improvement between laparoscopic sleeve gastrectomy and laparoscopic adjustable gastric banding

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Abstract
Background This study aimed to compare the rates for resolution and improvement of common comorbidities between laparoscopic sleeve gastrectomy (LSG) and laparoscopic adjustable gastric banding. The comorbid conditions included were type 2 diabetes mellitus (DM), hypertension (HTN), hyperlipidemias (LPD), degenerative joint disease (DJD), gastroesophageal reflux disease (GERD), obstructive sleep apnea (OSA), and asthma.
Methods A retrospective chart review of the patients who underwent LSG or laparoscopic adjustable gastric banding at our institution from July 2004 to July 2007 was performed. The resolution of comorbidities was determined via patient-completed questionnaires and objective data.
Results Of the 123 patients (29 men and 94 women) reviewed, 49 had undergone LSG, and 74 had undergone laparoscopic adjustable gastric banding. The mean preoperative body mass index (BMI) was 52 kg/m^2 for the LSG patients and 44 kg/m^2 for the laparoscopic adjustable gastric banding patients. The overall percentages of excess weight loss (%EWL) were respectively 50.6 and 40.3% ($P = 0.03$) during mean follow-up periods of 15 and 17 months. There was a greater resolution or improvement of DM after LSG (100% vs 46%), HTN (78% vs 48%), and LPD (87% vs. 50%) than after laparoscopic adjustable gastric banding. Other comorbidities resolved or improved at a similar rate.
Conclusions Although both LSG and laparoscopic adjustable gastric banding resulted in postoperative improvement or resolution of comorbidities associated with obesity, LSG statistically showed a significantly higher rate of resolution or improvement of DM, HTN, and LPD. There was no significant difference between the groups for DJD, GERD, OSA, or asthma.

Keywords Comorbidities · Laparoscopic adjustable gastric banding · Laparoscopic sleeve gastrectomy

Morbidly obese patients have a high prevalence of obesity-related comorbidities. Purely restrictive bariatric procedures such as laparoscopic sleeve gastrectomy (LSG) and laparoscopic adjustable gastric banding achieve a significant weight loss and effectively resolve or improve these comorbidities.

The sleeve gastrectomy was first introduced in 1988 by Hess as part of the biliopancreatic diversion with duodenal switch (BPD-DS) [1]. Gagner et al. [2] performed the first LSG as part of the laparoscopic BPD-DS. Subsequently, he performed the LSG as a staged procedure for the super-super obese patient [3].

Laparoscopic sleeve gastrectomy is becoming more popular because of its ability to provide a significant weight loss with a relatively short operative time and low complication rates. However, long-term studies are required to determine the durability of weight loss.

Laparoscopic adjustable gastric banding, introduced by Kuzmak et al. [4] and Forsell and Hallberg [5], is one of the most popular weight loss procedures in Europe. It became available in the United States in June 2001 when the laparoscopic adjustable gastric band was approved by the

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Food and Drug Administration (FDA). Two distinct adjustable band systems are used: the Lap-Band (Allergan, Irvine, CA) and the Realize Band (EthiconEndo-Surgery, Cincinnati, OH). Studies have found no difference in the complication rates or the amounts of weight loss between the two systems [6]. Laparoscopic adjustable gastric banding is very popular, with acceptable weight loss in long-term studies [7, 8].

Although weight loss is the primary goal of bariatric surgery, the effect of this weight loss on obesity-related comorbidities has a direct impact on quality of life and overall health status. Instruments such as the Bariatric Analysis and Reporting Outcome System (BAROS) [9] and the Short-Form 36 Health Survey (SF-36) have been used to measure the impact of bariatric surgery on these associated comorbidities [10, 11].

In a randomized trial, Himpens et al. [12] compared the weight losses after LSG and laparoscopic adjustable gastric banding, but the effect on comorbidities was not reported. No previous study compared the effect of these procedures on these comorbidities. This study aimed to compare the rates for resolution and improvement of the common comorbidities associated with obesity between LSG and laparoscopic adjustable gastric banding. The comorbid conditions included were type 2 diabetes mellitus (DM), hypertension (HTN), hyperlipidemias (LPD), degenerative joint disease (DJD), gastroesophageal reflux disease (GERD), obstructive sleep apnea (OSA), and asthma.

Materials and methods

We performed a retrospective chart review of the patients who underwent LSG and laparoscopic adjustable gastric banding at our institution from July 2004 to July 2007. The first 50 LSGs performed by two of the participating surgeons were included. Patients who underwent gastric banding during the same period also were included.

At each postoperative visit, the patients were required to complete a questionnaire that included a list of their current medications and dosages, symptoms related to their comorbidities, and their overall quality of life. Based on their answers and objective findings, we defined three categories that represented an effect on their comorbid conditions.

1. *Complete resolution*: complete cessation of symptoms or no current pharmacologic treatment
2. *Improvement*: decreased current pharmacologic treatment and severity of associated symptoms
3. *No effect*: no change in pharmacologic treatment or associated symptoms.

The criteria for the initial diagnosis of comorbidities are summarized in Table 1. The LSG was performed laparoscopically using four ports. The greater curvature was devascularized first, then removed by firing of a linear cutting stapler. The staple line began 5 cm from the pylorus and went up to the angle of His. The gastric sleeve was created over a calibrating bougie (mean, 46-Fr). A routine intraoperative endoscopy was performed to confirm hemostasis and check the integrity of the staple line.

Table 1 Criteria for the initial diagnosis of comorbidities

DM	PCP diagnosis, medical treatment and HbA1c
HTN	PCP diagnosis, medical treatment
LPD	PCP diagnosis, medical treatment, blood test
DJD	Symptoms and medical treatment
GERD	Symptoms and medical treatment
OSA	Preoperative sleep study. C-PAP machine use and symptoms
Asthma	Symptoms and medical treatment

DM type 2 diabetes mellitus, *HTN* hypertension, *LPD* hyperlipidemias, *DJD* degenerative joint disease, *GERD* gastroesophageal reflux disease, *OSA* obstructive sleep apnea

The laparoscopic adjustable gastric band (Allergan Inc.) was placed laparoscopically using the pars flaccida technique. Adjustments started at least 6 weeks after placement, and further adjustments were made as needed according to a postsurgical management plan previously described by Favretti et al. [13].

Of the 123 patients (29 men and 94 women) included in the study, 49 underwent LSG, and 74 had laparoscopic adjustable gastric banding. The patients did not differ significantly in terms of preoperative age or gender. The mean follow-up period was 15 months for the LSG group and 17 months for the laparoscopic adjustable gastric banding group. The groups differed significantly in terms of preoperative body weight, body mass index (BMI), and excess body weight (EBW). Table 2 summarizes the preoperative characteristics of each group.

The overall prevalence of obesity-related comorbid conditions was 90.2% (111 of the 123 patients). In the LSG group, 46 of the 49 patients (94%) reported at least a single

Table 2 Preoperative characteristics

	LSG	LAGB	*P* value
N	49	74	
Age	45 ± 12	41 ± 14	NS
Sex (M/F)	13/36	16/58	NS
Preoperative BMI (kg/m^2)	52 ± 11	44 ± 5	<0.01
EBW (kg)	81.8 ± 35	59 ± 18.7	<0.01
Body weight (kg)	144.0 ± 39.2	122.7 ± 22.7	<0.01
Follow-up (months)	15 ± 11	17 ± 10	NS

LSG laparoscopic sleeve gastrectomy, *LAGB* laparoscopic adjustable gastric banding, *EBW* excess body weight, *BMI* body mass index, *EBW* excess body weight

Table 3 Prevalence of comorbidities preoperatively

	LSG ($n = 49$) % (n)	LAGB ($n = 74$) % (n)	P value
DM	29 (14)	17 (13)	NS
HTN	47 (23)	45 (33)	NS
LPD	30 (15)	43 (32)	NS
DJD	45 (22)	40 (29)	NS
GERD	18 (9)	12 (9)	NS
OSA	40 (20)	16 (12)	<0.01
Asthma	32 (16)	20 (15)	NS

LSG laparoscopic sleeve gastrectomy, *LAGB* laparoscopic adjustable gastric banding, *DM* type 2 diabetes mellitus, *HTN* hypertension, *LPD* hyperlipidemias, *DJD* degenerative joint disease, *GERD* gastroesophageal reflux disease, *OSA* obstructive sleep apnea

comorbidity compared with 65 of the 74 patients (87.8%) in the laparoscopic adjustable gastric banding group. The most prevalent comorbidity in both groups was HTN, experienced by 56 patients (45.5%). The least-reported comorbidity was GERD, experienced by 18 patients (15%). The only significant difference between the groups was in the preoperative prevalence of OSA. Table 3 presents the prevalence of comorbidities preoperatively.

We used Fisher's exact test and the t-test to determine the statistical significance of the reported rates for resolution and improvement of comorbidities and other variables between the two groups. A P value less than 0.05 was considered significant.

Results

There were no mortalities or major complications related to the procedures. The rate of minor complications was 12% for the LSG group and 15% for the laparoscopic adjustable gastric banding group.

There was a marked difference in the parameters of weight loss between the two groups. The percentage of excess weight loss (%EWL) in the LSG group was 20.6 ± 11 at 3 months for 85.7% (42 of the 49 patients), 39.5 ± 16 at 6 months for 44.8% (22 of the 49 patients), and 50.6 ± 19 beyond 12 months of follow-up evaluation for 46.7% (23 of the 49 patients). In contrast, the %EWL in the laparoscopic adjustable gastric banding group was 18.5 ± 8 at 3 months for 81% (60 of the 74 patients), 25.2 ± 12 at 6 months for 45.9% (34 of the 74 patients), and 40.3 ± 19 at beyond 12 months of follow-up evaluation for 62.1% (46 of the 74 patients). Figure 1 shows the change in %EBW at 3 month intervals.

Other weight loss parameters beyond 1 year of follow-up evaluation are summarized in Table 4. Failure, defined as %EWL less than 25% accordingly to Reinhold's criteria [14], was 22% in the LSG group and 46% in the laparoscopic adjustable gastric banding group at 15 and 17 months, respectively.

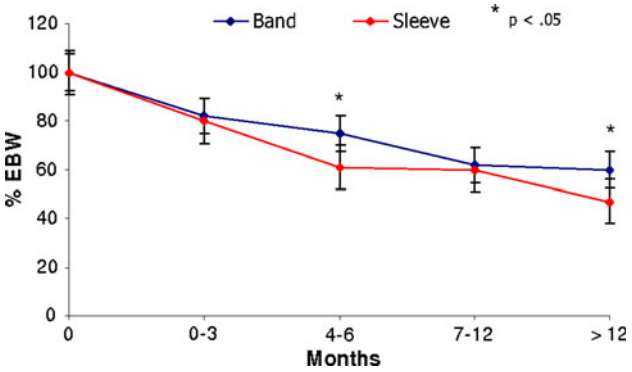

Fig. 1 Changes in percentage of excess body weight (%EBW) at 3 month intervals

Table 4 Parameters of weight loss beyond 1 year of follow-up evaluation

	LSG	LAGB	P value
Postoperative weight (kg)	104.6 ± 35.5	101.1 ± 21.3	NS
Total weight loss (kg)	39.2 ± 14.8	22.5 ± 9.8	<0.01
Decrease in BMI (kg/m^2)	14.2 ± 5.5	8.0 ± 3.3	<0.01
% EWL (%)	50.6 ± 19	40.3 ± 11	0.03

LSG laparoscopic sleeve gastrectomy, *LAGB* laparoscopic adjustable gastric banding, *BMI* body mass index, *EWL* excess weight loss

The mean rate of resolution or improvement in comorbidities for the LSG group was 68.2% compared with 49.1% for the laparoscopic adjustable gastric banding group. In the LSG group, DM, HTN, and LPD resolved or improved at a higher rate. Other comorbidities such as OSA, DJD, GERD, and asthma resolved or improved at

Table 5 Resolution or improvement of comorbidities after laparoscopic sleeve gastrectomy (LSG) vs laparoscopic adjustable gastric banding (LAGB)

Comorbidity	LSG % (n)	LAGB % (n)	P value
DM ($n = 27$)	100 (14/14)	46 (6/13)	<0.01
HTN ($n = 56$)	78 (18/23)	48 (16/33)	0.03
LPD ($n = 47$)	87 (13/15)	50 (16/32)	0.02
DJD ($n = 51$)	73 (16/22)	69 (20/29)	NS
GERD ($n = 18$)	22 (2/9)	33 (3/9)	NS
OSA ($n = 32$)	55 (11/20)	25 (3/12)	NS
Asthma ($n = 31$)	63 (10/16)	73 (11/15)	NS

DM type 2 diabetes mellitus, *HTN* hypertension, *LPD* hyperlipidemias, *DJD* degenerative joint disease, *GERD* gastroesophageal reflux disease, *OSA* obstructive sleep apnea

similar rates in both groups. These results are summarized in Table 5.

Discussion

Purely restrictive bariatric procedures have gained popularity among patients and bariatric surgeons due to a relatively low rate of complications and a shorter learning curve. Studies have shown that these operations can have a major impact on obesity and related comorbidities. This current study is the first to report the effect of laparoscopic adjustable gastric banding and LSG on comorbidities in a comparative analysis.

Our results showed a significantly higher weight loss in the sleeve gastrectomy group. Both operations are followed by a decrease in appetite, with normal gastric emptying [15, 16]. However, changes in gastrointestinal hormones may explain some of the decrease in appetite and subsequent weight loss. In a randomized trial, Langer et al. [17] reported decreased Ghrelin levels 6 months after LSG, in contrast to raised Ghrelin levels after laparoscopic adjustable gastric banding. Consequently, the LSG group had a higher mean %EWL (61% ± 16%) than the laparoscopic adjustable gastric banding group (29% ± 11%).

The greater reduction in hunger after LSG is believed to be due to resection of the gastric fundus, which produces Ghrelin. The role of Ghrelin as a predictor of weight loss after laparoscopic adjustable gastric banding was challenged by Busetto et al. [18]. In their series, a high-fasting Ghrelin concentration preoperatively did not predict poor weight loss in a group of morbidly obese women. Another gastrointestinal hormone to consider is peptide YY, a hunger-reducing hormone produced in the distal ileum that reportedly increases after LSG [19]. However, the mechanisms of weight loss after these procedures are not clearly understood.

Another factor is patient compliance and motivation. Laparoscopic adjustable gastric banding requires frequent timely visits for adjustments to sustain a degree of restriction essential to achieve significant weight loss. Reports have linked consistency in follow-up visits and greater weight loss after bariatric surgery [20]. Dixon et al. [21] reported that nonpsychological factors such as increasing age, decreased physical ability, and elevated insulin resistance have a greater influence on weight loss.

The impact of LSG on obesity-related comorbidities has been reported in very few studies. For a small series of patients undergoing LSG, Moon et al. [22] reported 100% resolution or improvement of DM and 93% resolution or improvement of HTN after 12 months. Cottam et al. [23] reported respective reductions of 92 and 85% for the same comorbidities. Other smaller series also have reported good results [24, 25].

The impact of laparoscopic adjustable gastric banding on different comorbidities has been reported in a very large metaanalysis by Buchwald [26], which showed improvement or resolution of DM in 86% of patients. In an earlier metaanalysis, Buchwald [26] reported improvement or resolution of HTN in 71%, LPD in 78%, and DM in 80% of patients [27]. Ponce et al. [28] reported that greater %EWL resulted in high rates of HTN resolution and improvement.

The LSG patients in our study experienced a more significant weight loss and also a greater effect on DM (100%), HTN (78%) and LPD (87%). Our study confirms that LSG is able to provide significant weight loss and a better resolution of the comorbidities associated with the metabolic syndrome.

Conclusions

Although both LSG and laparoscopic adjustable gastric banding resulted in postoperative improvement or resolution of comorbidities associated with obesity, LSG showed a significantly higher rate of resolution or improvement of DM, HTN, and LPD. The groups did not differ significantly in the rates for resolution and improvement of DJD, GERD, OSA, or asthma. Larger studies, preferably randomized studies with long-term follow-up evaluation, are needed to demonstrate the durability of these effects.

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