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SURGICAL ENDOSCOPY
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Laparoscopic adjustable gastric band versus laparoscopic Roux-en-Y gastric bypass

Ends justify the means?

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Abstract
Background: In the United States, the most frequently performed bariatric procedure is the Roux-en-Y gastric bypass (RYGB). Worldwide, the most common operation performed is the laparoscopic adjustable gastric band (LAGB). The expanding use of LAGB is probably driven by the encouraging data on its safety and effectiveness, in contrast to the disappointing morbidity and mortality rates reported for RYGB. The aim of this study was to evaluate the results of LAGB versus RYGB at a single institution.
Methods: Between November 2000 and July 2004, 590 bariatric procedures were performed. Of these, 120 patients (20%) had laparoscopic RYGB and 470 patients (80%) had LAGB. A retrospective review was performed.
Results: In the LAGB group, 376 patients (80%) were female, and the mean age was 41 years (range, 17–65). In the RYGB group, 110 patients (91%) were female, and the mean age was 41 years (range, 20–61). Preoperative body mass index was 47 ± 8 and 46 ± 5, respectively (p = not significant). Operative time and hospitalization were significantly shorter in LAGB patients ($p < 0.001$). Complications and the need for reoperation were comparable in both groups. Weight loss at 12, 18, 24, and 36 months for LAGB and RYGB was 39 ± 21 versus 65 ± 13, 39 ± 20 versus 62 ± 17, 45 ± 25 versus 67 ± 8, and 55 ± 20 versus 63 ± 9, respectively.
Conclusions: The current study demonstrates that LAGB is a simpler, less invasive, and safer procedure than RYGB. Although mean percentage excess body weight loss (%EBWL) in RYGB patients increased rapidly during the first postoperative year, it remained nearly unchanged at 3 years. In contrast, in LAGB patients weight loss was slower but steady, achieving satisfactory %EBWL at 3 years. Therefore, we believe that LAGB should be considered the initial approach since it is safer than RYGB and is very effective at achieving weight loss.

Key words: Morbid obesity — Laparoscopic adjustable gastric band — Roux-en-Y gastric bypass — Weight loss — Morbidity/Mortality

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The World Health Organization has declared that obesity is a disease of pandemic significance. Obesity has for many years been ignored as a disease. As a result, practitioners in the medical community have been preoccupied with treating weight-related diseases (i.e., coronary artery disease, diabetes mellitus, hypertension, osteoarthritis, sleep apnea, gastroesophageal reflux, etc.). Nevertheless, obesity is a disease that may be prevented by modifying the "obesogenic" environment [26]. Undoubtedly, lifestyle modifications, changes in dietary habits, and physical activity are major determinants for success. However, such strategies have not generally been successful for long-term weight maintenance. For this reason, surgery has become an alternative for weight reduction in patients with clinically severe obesity when less invasive methods of weight loss have failed and patients are at high risk for obesity-associated morbidity or mortality [14]. The evolution of bariatric surgery has been aimed at all times toward safer and more effective procedures. During the past 40 to 50 years, Roux-en-Y gastric bypass (RYGB) has been the preferred surgical procedure performed by bariatric surgeons in the United States. However, this operation has always been challenged by alternative surgical procedures. After its introduction in 1966, the adversary was the jejunalileal bypass—an operation that was quickly abandoned due to its increased complication rate [8]. Interestingly,

Mason et al., who first described gastric bypass [11], also first conceived of the idea of a purely restrictive operation [20] in search of a more physiologic approach. As a consequence, gastroplasties [i.e., vertical banded gastroplasty (VBG)] became a promising alternative with no rerouting of the digestive tract. Ultimately, studies suggested that RYGB induced a considerably higher weight loss compared to VBG [10]; this was probably related to the poor long-term weight control and the nonadjustability of this purely restrictive approach. Currently, the "new kid on the block" is the adjustable gastric band, an operation that has gained popularity due to the adjustability and reversibility of the procedure. More than 100,000 adjustable gastric bands have been placed worldwide since the introduction of the laparoscopic approach in 1993 [1, 7], making this the most common bariatric procedure performed. However, this is not the case in the United States, where the gastric band was approved by the Food and Drug Administration (FDA) in June 2001. In addition, the disappointing results reported by DeMaria and colleagues [5] have made the widespread acceptance of the method difficult. However, the expanding use of the laparoscopic adjustable gastric band (LAGB) is probably driven by the encouraging data on its safety and effectiveness coming not only from Australia and Europe but also from the United States [21, 22]. The aim of this study was to evaluate the results of LAGB versus RYGB at a single institution.

Materials and methods

The study population is represented by all patients who underwent either RYGB or LAGB at the Minimally Invasive Surgery Center of the University of Illinois between November 2000 and December 2004. Patients were either self-referred or referred by their primary care physician. The operations were performed by two advanced laparoscopic surgeons with adequate fellowship training in bariatric surgery. The preferred gastric band device used was the Lap-Band system (Inamed Health, Santa Barbara, CA, USA). Until February 2004, the 10-cm Lap-Band was used in every case; after that, whenever removal of the fat pad was considered necessary, the 11-cc band was utilized.

Patient eligibility

According to the National Institutes of Health [14], potential candidates for bariatric surgery are patients with a body mass index (BMI) ≥ 40 kg/m^2 or those with a BMI ≥ 35 kg/m^2 with associated comorbid conditions. All candidates were 18 years old or older at the beginning of the study. However, in the latter part of the study after FDA approval was obtained, a clinical trial was ongoing that included patients between 14 and 17 years old at our institution. Patients >65 years old were thoroughly assessed before surgery. Evidence of previous successful and unsuccessful weight loss attempts by either dietary or weight loss drug therapy was requisite in every patient. Patients with dependency on alcohol or drugs were ineligible surgical candidates. Psychosis or uncontrolled depression were also contraindications for bariatric surgery. Patients' comprehension and acceptance of the selected procedure were critical. Patients were also advised of the importance of regular follow-up for optimal results. At the beginning of the experience, patients who had a BMI >50 were not considered suitable candidates for laparoscopic RYGB. There was no BMI restriction for LAGB surgery.

Preoperative evaluation

Patients were asked to attend to an information session during which supplementary information about LAGB or RYGB was given. The preoperative evaluation was performed by a multidisciplinary team composed of a psychologist, internist, cardiologist, gastroenterologist, nutritionist, and surgeons.

In order to qualify for surgery, patients were required to have the following preoperative workup: CBC, chemistry panel, lipid profile, liver function tests, urine analysis, pregnancy test, chest X-ray, electrocardiogram, and a psychological evaluation. Before lap band surgery, all patients were required to undergo upper gastrointestinal study and esophageal manometry to assess the motility of the esophagus. In potential gastric bypass patients, an abdominal ultrasound was required. Special tests were ordered if warranted (prolactin, thyroid panel, and cortisol level). Once patients were considered acceptable surgical candidates, it was recommended by the surgeon and dietitian that they follow a low-sugar liquid diet 10 days before surgery. Patients with diabetes were recommended to consume 15 g of carbohydrates every 1 or 2 h and to monitor blood sugar regularly.

Surgical technique

Routinely, a single dose of preoperative prophylactic antibiotics (first-generation cephalosporin) was used. Sequential compression device stockings were placed in both extremities before induction of general endotracheal anesthesia. Also, a single dose of 5000 U of subcutaneous heparin was used. After induction of general anesthesia, an OG tube was regularly placed. In patients undergoing RYGB, a Foley catheter was placed. The regular use of the "bean bag" prevents the patient from sliding off the operating room table when steep reverse Trendelenburg is needed.

Laparoscopic adjustable gastric band technique

After general anesthesia was achieved, the patient was placed in the semilithotomy position. The skin of the abdomen was prepped and draped in the usual sterile fashion. The first trocar was inserted using the Optiview, one handbreadth from the left costal margin, two fingers off midline. This is a 10- to 12-mm port for the 30° camera. Pneumoperitoneum was induced with CO_2 up to 20 mmHg. Next, all the additional trocars were placed under direct view. The second trocar, 5-mm (right-hand working port), was inserted in the left upper quadrant, midclavicular line, two fingers below the costal margin. The third trocar was positioned at the level of the left anterior axillary line for the assistant. This is an 18-mm trocar that allows the introduction of the band into the abdomen. Before insertion of the liver retractor, the patient was placed in steep anti-Trendelenburg position. A 0.5-cm incision was made in the subxyphoid area, and the left lobe of the liver was then retracted anteriorly using the Nathanson retractor. The operation was started by bluntly taking down the peritoneal attachments of the gastric fundus without dividing any short gastric vessels. After this was accomplished, the pars flaccida was opened below the hepatic branch of the vagus nerve (pars flaccida technique). The right crus was identified, and a small retrogastric window was created using blunt dissection. In case of doubt, upper endoscopy was helpful to rule out gastric perforation. The band was introduced through the 18-mm port; the tubing was grasped at the angle of His passed through the window created behind the stomach. If needed the fat pad was removed using the harmonic scalpel. If fat pad removal was not necessary, the band was positioned around the stomach and locked in place. Three anterior gastrogastric sutures of 2–0 silk were placed to maintain the band in position. The first was placed in the left lateral aspect of the gastric pouch and the other two in the anterior aspect. The wrap was performed using the suture assistant device (Ethicon Endo-Surgery). The liver retractor was removed under direct vision, and the tubing of the band was exteriorized through the trocar in the left upper quadrant. The patient's trocars were then removed. The pneumoperitoneum was evacuated. At this time, a subcutaneous pocket was created using the 18-mm incision to expose the muscle fascia of the rectus. The tubing of the band was connected to the port, and the port was

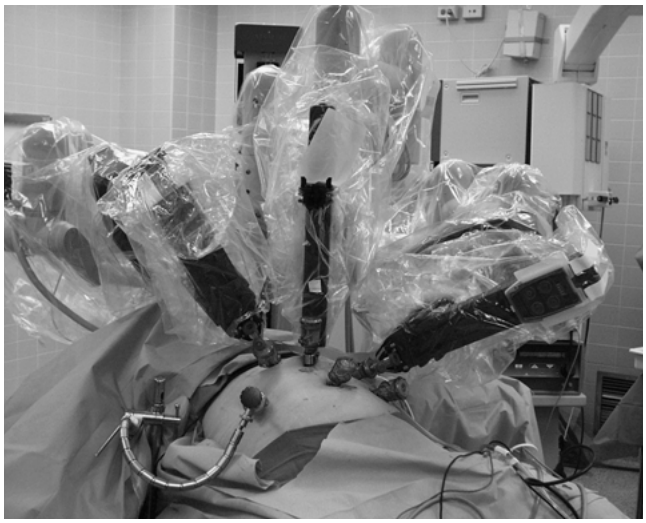

Fig. 1. LRYGB port positioning.

positioned in the left upper quadrant in the subcutaneous position in the anterior wall fascia with 2–0 prolene. Incisions were closed with subcuticular stitches of absorbable material and the skin approximated with biological glue.

Robotically assisted Roux-en-Y gastric bypass technique

This technique has been previously described by our group [13]. The patient was placed in the low lithotomy position with the legs and arms open. The trocar placement for robotically assisted RYGB is shown in Fig. 1. The procedure was started laparoscopically by dividing the small bowel approximately 50 cm below the angle of Treitz using a vascular stapler; the mesentery of the bowel was also divided using a vascular stapler. After creating a 150-cm limb, a jejunojejunal anastomosis was performed using two reloads of vascular staplers. The bowel opening was closed with interrupted stitches of 3–0 silk. The defect between the mesentery was closed using a 3–0 silk suture. At this time, the patient was placed in a reverse Trendelenburg position, and a 0.5-cm incision was made in the subxyphoid area. The left lobe of the liver was then retracted anteriorly using the Nathanson retractor. The gastroesophageal junction was visualized, and the angle of His was bluntly dissected from its diaphragmatic attachments. The omentum was mobilized and sectioned using the harmonic scalpel. Next, beginning at the lesser curve (approximately 5 cm from the gastroesophageal junction); the retrogastric tunnel was created using the harmonic scalpel and the lesser sac was entered. Several loads of the 3.5-mm linear stapler were used to create an approximately 30-cm^3 gastric pouch; following completion, the distal portion of the ileum was brought up for creation of the antecolic–antegastric gastrojejunostomy. At this time, the surgical arm cart of the da Vinci Surgical System (Intuitive Surgical, Sunnyvale, CA, USA) was positioned. To perform the gastrojejunal anastomosis, a Cadière forceps was attached to the right arm and a needle holder to the left arm. The posterior layer of the gastrojejunal anastomosis was performed with interrupted 3–0 silk. Then, using electrocautery, a 1.5-cm opening was created in both the jejunum and the gastric pouch; for the opening, the articulated cautery was hooked to the left arm. Once the bowel and the stomach were opened, the hand-sawn anastomosis was started with the assistance of the robot. The inner layer of the anastomosis was performed using running 3–0 absorbable suture to complete the posterior and anterior wall. The anterior serosa layer of the gastrojejunal anastomosis was closed using interrupted 3–0 silk. Once the anastomosis was finished, the robotic surgical cart was removed from the patient. The nasogastric tube was passed down into the gastric pouch. The distal limb of the ileum was clamped, and 60 ml of methylene blue was injected to rule out the presence of leaks.

Postoperative management

LAGB

Patients with no major pulmonary (especially obstructive sleep apnea) or cardiac comorbid conditions and with a BMI < 75 were considered acceptable candidates for outpatient surgery. In the recovery area, these patients were stimulated for early deambulation and fluid tolerance. A gastrograffin swallow was performed before discharge to evaluate band position and contrast passage. Patients who did not qualify for outpatient surgery stayed overnight for better monitoring. The gastrograffin swallow was performed the following morning.

RYGB

Patients were encouraged to ambulate on the same operative day. On postoperative day 1, patients underwent a gastrograffin swallow to evaluate the status of the gastrojejunal anastomosis. If no extravasation of contrast or obstruction were noted, they were started on a clear liquid diet as tolerated. On postoperative day 2, if uneventful, patients were discharged home.

Follow-Up

Patients and all pertinent information were listed prospectively in a computerized database and the data were retrospectively reviewed.

LAGB

Patients were seen 1 week after surgery. The second visit was 4 to 6 weeks after surgery, typically for first adjustment. After the second visit, patients were seen every 2 months for the first year, unless they met the criteria for an adjustment (i.e., feeling hungry, not losing 2 pounds per week, and not feeling early satiety), in which case they were seen on an as needed basis. All the adjustments were performed under fluoroscopy (''tailored adjustment''). Before surgery, patients were given postoperative dietary guidelines, which included eating pattern changes not only to prevent possible complications but also to produce the desired weight loss. It was suggested that patients include protein foods and foods containing vitamins and minerals in their diet, and restrict as much as possible carbohydrates, fat, and alcohol. At every postoperative visit, patients were weighted; they were asked about the evolution of their preoperative comorbid conditions and had a dietician consultation. Sixty-four percent of patients in this group were considered for follow-up at the time of the study. The total length of follow-up for these patients was 15 ± 8 months.

RYGB

Patients were seen 1 week after surgery and every 3 months for the first year. After this, they were seen at regular 6-month intervals or they were followed by a telephone interview performed by a nurse practitioner or a fellow. During each follow-up visit, patients were weighted and detailed symptomatic evaluation was obtained. Dietician counseling was offered in every case. It was recommended that patients take multivitamins on a daily basis after surgery. Also, if patients had a gallbladder in situ, they were put on ursodeoxycholic acid for a 6-month period to prevent the formation of gallstones. Before discharge from the hospital, patients were given specific dietary guidelines as well. They were instructed to take vitamins and minerals for life (i.e., vitamin B complex, biotin, calcium, and zinc). It was recommended that women aim for a daily intake of 50 g of protein and men 63 g. Of this cohort, 60% of patients were on active follow-up and were the subject of this review. The length of follow-up in this group was 16 ± 7 months.

Statistical analysis

Data were retrospectively reviewed from a prospectively collected computerized database. To compare continuous variables between the

two groups, paired Student's *t*-test was used. Categorical variables were compared using the chi-square test or, when appropriate, Fischer's exact test was performed. Also, analysis of variance was used as necessary. All results are expressed as mean ± standard deviation unless otherwise stated. Differences were considered significant at $p < 0.05$.

Results

Patient overview

A total of 590 consecutive bariatric procedures were performed at our institution for the treatment of severe obesity. During the last 2 years of the study, a dramatic increase in the amount of patients referred for weight loss surgery was observed, as demonstrated by 62% of procedures performed occurred during this period. As a consequence, for both surgical techniques there was a steady increase in the number of procedures completed. Overall, 120 patients (20%) underwent laparoscopic RYGB and 470 patients (80%) LAGB. In the LAGB group, 376 patients (80%) were female, and 94 (20%) were male. The mean age in this group was 41 years (range, 17–65). In the RYGB group, 110 patients (91%) were female and 10 (9%) were male. The mean age was 41 years (range, 20–61). Table 1 shows the demographic data for both groups. No significant differences were found for age, preoperative BMI, and comorbid conditions. However, the percentage of male patients within the LAGB group was significantly higher compared to the RYGB group. Within the adjustable gastric band group, 112 patients (24%) with a BMI >50 (range, 51–60) were considered superobese, and 26 patients (6%) were considered super-superobese with a BMI >60 (range, 61–83). In contrast, only 19 patients (16%) had a BMI >50 (range, 51–66) in the gastric bypass group.

Operative and postoperative course

The operation was completed laparoscopically in 586 of 590 patients (99%). In the gastric bypass group, 10 patients underwent a total laparoscopic approach and 110 patients had a robotically assisted procedure. Conversion to open laparotomy was required in one patient (0.2%) in the LAGB group and in three patients (2.5%) in the RYGB group. For the LAGB patient, conversion was necessary due to hepatomegaly, lack of appropriate exposure, and bleeding. Conversion to open procedure in the gastric bypass group occurred within the first 30 cases. The first conversion was necessary because during the jejunojejunostomy the distal end of the bowel was anastomosed to itself, creating a closed loop. The second and third conversions occurred during the creation of the jejunojejunostomy. In both cases, the linear cutting stapler cut but did not deploy any staples. Operative times for RYGB were noticeably longer than for LAGB (209 ± 39 vs 66 ± 26, $p = 0.001$), even though the time decreased substantially (i.e., 60 min) after the first 50 cases. Operative time in the last 200 gastric bands performed was 47 ± 14 min. Blood loss for LAGB patients was less than that for RYGB patients (12 ± 10 vs 31 ± 31, $p = 0.001$). Hospital stay for gastric bypass patients was 55 ± 17 h (range, 24–163). Specifically, 38% of patients left the hospital within 48 h, whereas the majority (53%) left within 72 h. Hospitalization time for lap band patients was 22 ± 25 h. In this group, 37% of patients had an outpatient procedure with a mean hospital stay of 9 ± 2 h, and 54% of patients were discharged within 23 h. In the last 200 cases, 77% of patients met the criteria for LAGB as an outpatient procedure.

Table 1. Demographics among LAGB and RYGB

	LAGB ($n = 470$)	RYGB ($n = 120$)	p value
Gender (female/male)	376/ 94	110/10	
Age (yr)	41 ± 10	41 ± 10	NS
Preop BMI (kg/m^2)	47 ± 8 (35–83)	46 ± 5 (37–66)	NS
Preop comorbidities			
HTN (% patients)	54	47	NS
NIDDM (% patients)	24	22	NS
GERD (% patients)	49	38	NS
SA (% patients)	31	20	NS
OA/DJD (% patients)	58	64	NS
Depression (% patients)	40	40	NS

BMI, body mass index; GERD, gastroesophageal reflux disease; HTN, hypertension; NIDDM, non-insulin-dependent diabetes mellitus; NS, not significant; OA/DJD, osteoarthritis/degenerative joint disease; SA, sleep apnea

Early complications (< 30 days)

LAGB

An intraoperative perforation of the posterior wall of the stomach occurred during the creation of the retrogastric window. The gastric hole was closed primarily with interrupted suture, and the band was placed in the same operation. One patient was readmitted 2 days after discharge for workup for pulmonary embolism. Lower extremity venous duplex was negative; due to the patient body habitus, she was unable to undergo CT scan, V/Q scan, and/or pulmonary angiogram. Subsequently, empiric treatment with heparin drip was initiated. During the course, the patient improved clinically. A total of 15 patients (3%) developed postoperative acute obstruction. All of them received conservative treatment, with an average hospitalization of 4 days (Table 2).

RYGB

Only one patient in this group developed pulmonary complications. This patient developed pneumonia on postoperative day (POD) 1. Gastrointestinal complications were more common. One patient developed an early small bowel obstruction (SBO) due to an internal hernia. The same patient developed a leak of the gastrojejunostomy 2 days following repair of internal herniation. The patient was therefore taken back to the operating room for repair of the gastrojejunostomy and drainage. A second patient developed a partial obstruction due to edema of the gastrojejunostomy

Table 2. Early and late complications after LAGB and RYGB

LAGB (n = 470)		Reoperation		RYGB (n = 120)	
Complication				Complication	
Early complications					
Gastric perforation	1 (0.2%)	—	—	1 (0.8%)	Pneumonia
PE	1 (0.2%)	—	1	1 (0.8%)	SBO
Acute obstruction	15 (3.1%)	—	—	1 (0.8%)	Stomal stenosis
Death	—	—	—	1 (0.8%)	Staple line bleeding
			—	2 (1.6%)	Wound infection
			1	1 (0.8%)	Abdominal pain
			1	1 (0.8%)	Death
Subtotal	17 (3.6%)	—	3 (2%)	8 (7%)	
Late complications					
Pouch enlargement	56 (12%)	11	—	4 (3%)	Marginal ulcer
Band slippage	12 (2%)	12	1	3 (2%)	Stomal stenosis
Band erosion	1 (0.2%)	2	4	4 (3%)	SBO
Port/tubing comp.	13 (2.7%)	13	1	1 (0.8%)	Gastrogastric fistula
			1	1 (0.8%)	Gallstones
			—	4 (3%)	Anemia
Subtotal	82 (17%)	38 (8%)	7 (6%)	17 (14%)	
Total	99 (21%)	38 (8%)	10 (8%)	25 (21%)	Total

SBO, small bowel obstruction
PE, Pulmonary embolism

(G-J) anastomosis. This patient was managed conservatively. A third patient developed a wound infection after conversion to an open procedure. An additional patient was noted to have bright red blood per rectum and falling hemoglobin on POD 2. The patient was transferred to the intensive care unit and was transfused with 3 U of red blood cells. The bleeding abated spontaneously, with no further bleeding at discharge. Another patient was readmitted on POD 3 complaining of diffuse abdominal pain. An exploratory laparoscopy ruled out anastomotic leak or bowel obstruction. There was one death (0.8%) in this group, which was due to necrosis of the Roux limb.

Late complications

LAGB

The most common late adverse events after the lap band was placed were pouch enlargement and band slippage (Table 2). Pouch enlargement, considered when the gastric pouch was dilated without obstruction, was present in 56 patients (12%). Band deflation was attempted in every case with a 77% success rate. Of those who failed to resolve with band deflation, an operation was needed in 11 patients (band repositioning in nine and band removal in two). Band slippage, defined as the cephalic prolapse of the distal stomach with slippage of the band, occurred in 3% of patients. All these patients complained of dysphagia and vomiting, which indicated complete outflow obstruction. Despite the fact that nonsurgical treatment was attempted in every case, ultimately band repositioning was necessary in 10 patients and two patients decided to have their band removed. Only one patient (0.2%) developed erosion of the band into the stomach requiring band removal. In one case, 3 months after surgery, the decision to remove the band was made because of the inability of the patient to adapt to the new lifestyle. An additional patient with suboptimal weight loss 18 months after lap band surgery decided to have the band removed and subsequent conversion to a gastric bypass. All the reoperations were successfully completed laparoscopically. Port and tubing complications were present in 13 patients (3%), all of which were managed by replacing the port under sedation and local anesthesia. No major complications or death occurred in this group.

RYGB

Seventeen patients (14%) developed complications distant from the initial operation site. Marginal ulceration, stomal stenosis, and SBO were among the more frequent major complications (Table 2). Four patients developed ulceration located on the jejunal side of the G-J anastomosis. Nonoperative treatment was effective in three of them. The remaining patient developed upper gastrointestinal bleeding with visible vessel requiring 2 U of red blood cells and endoscopic sclerosis. A total of three stomal stenosis occurred; these patients received repeated upper endoscopy with dilatations of the gastrojejunostomy. One patient had a perforation at the G-J anastomosis after forceful dilatation. The patient was taken to the operating room for exploratory laparotomy and re-creation of the gastrojejunostomy. SBO occurred in four patients, all of whom required surgical management. One patient developed an incarcerated incisional hernia through the umbilical trocar site. A second patient had SBO secondary to adhesions requiring diagnostic laparoscopy with lysis of adhesions. A third patient had a small stricture with adhesions that was diagnosed and taken down during an exploratory laparoscopy. An additional patient underwent an open revision and reduction of an internal hernia. Gastrogastric fistula was seen in one patient 28 months after the

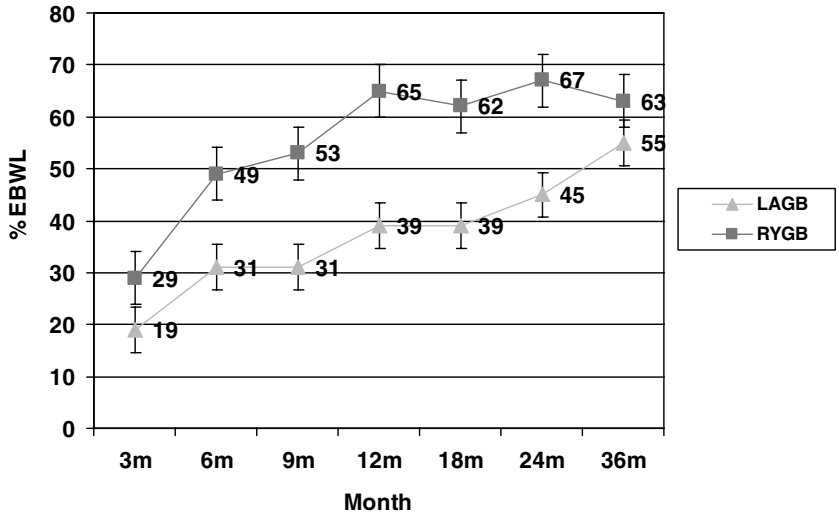

Fig. 2. Comparison of %EBWL (LAGB vs RYGB).

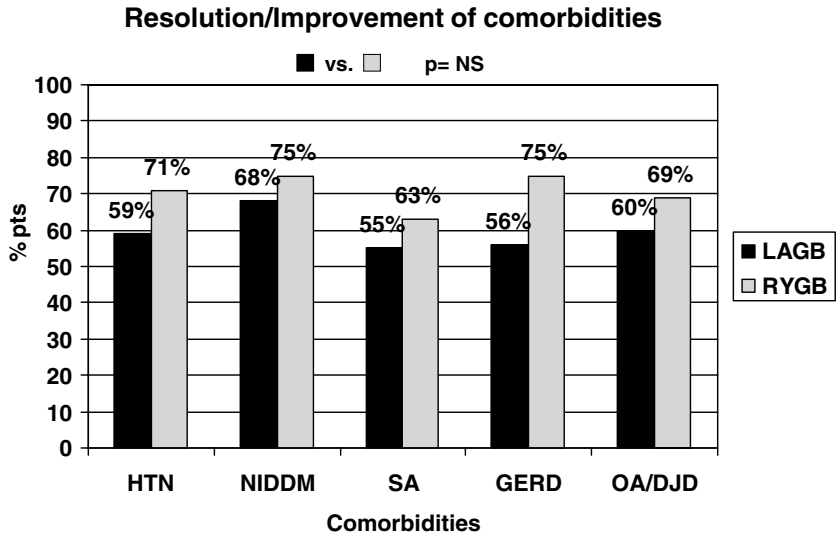

Fig. 3. Change in preoperative comorbid conditions (LAGB vs RYGB).

original gastric bypass. This patient underwent a successful laparoscopic revision and division of the fistula. Interestingly, on POD 5 this patient developed an internal hernia, which required exploratory laparoscopy and repair. One patient developed gallstones and required a laparoscopic cholecystectomy 6 months after surgery. Four patients developed microcytic anemia due to nutritional deficiencies. No deaths occurred during this period.

Weight loss and comorbid conditions

The mean percentage excess body weight loss (%EBWL) at 3, 6, 9, 12, 18, 24, and 36 months is summarized in Fig. 2. Weight loss for gastric bypass patients was statistically significant at each time point ($p < 0.001$). Changes in preoperative comorbid conditions for both surgical procedures are shown in Fig. 3. No difference [p = not significant (NS)] was observed in resolution/improvement of comorbid conditions when the groups were compared.

Discussion

Surgery is the only tool available for sustained and effective long-term weight loss. There is consensus regarding the attributes of an ideal bariatric operation. The operation should be effective with regard to weight loss and comorbidities, and it should result in an increased quality of life. It should also have a low complication rate, with minimal side effects. For many years, bariatric surgeons in the United States have assumed that gastric bypass is the ideal operation for the management of clinically severe obesity [19]. These asseverations were reinforced by the emergence of laparoscopic surgery in the field [27]. The introduction of laparoscopy to bariatric surgery resulted in less blood loss and postoperative pain, shorter hospital stay, faster recovery time, and decreased morbidity associated with open surgery [15]. Although gastric bypass has been shown to be safe and effective in maintaining long-lasting weight loss, it is associated with a steep learning curve and high complication rate [18, 24]. In our series of gastric bypass patients, 76% of the complications and three conver-

sions to open surgery occurred within the first 60 cases, indicating the effect of the learning curve.

LAGB is associated with a shorter learning curve and decreased perioperative complications compared to gastric bypass [2]. The incidence of complications decreases with experience [6]. This is demonstrated by the results of this cohort, in which LAGB was associated with shorter operative time (66 ± 26 vs 209 ± 39, $p = 0.001$) and less blood loss. Although in gastric bypass patients operative time declined substantially (i.e., 60 min) after the first 60 cases, it is worth mentioning that surgical time for LAGB in the last 200 patients performed also declined to 47 ± 14 min. The other remarkable finding, since this is a high-risk population, concerns the hospitalization time of both groups. Hospital stay for gastric bypass patients was 55 ± 17 h (range, 24–163). In this group, 38% of patients were discharged within 48 h, whereas the majority of patients (62%) were discharged within 72 or more hours. In contrast, the hospital stay for lap band patients was 22 ± 25 h ($p = 0.001$). In this group, 37% of patients had an outpatient procedure with a mean hospital stay of 9 ± 2 h, and 54% of patients were discharged the following morning (23 h). Furthermore, for the last 200 lap bands placed, 77% of patients were discharged the same day of surgery, demonstrating the reduced invasiveness of this procedure. In the perioperative period, the complications associated with both procedures were also in favor of LAGB patients (Table 2). Two major complications occurred in the latter group. One patient had an intraoperative gastric perforation and a second patient had a pulmonary embolism. The most common adverse effect in this stage was band-related obstruction of the stoma (3.1%). These events occurred before 2004, when we started using the larger version of the lap band system. No reoperations were required, and no patient died in the perioperative period or during follow-up after lap band.

Early complication rate after RYGB is 5–30%, and these complications have a tendency to be more severe than in LAGB. In this series, 7% of patients developed complications within 4 weeks of the initial operation. SBO with a G-J anastomosis leak, staple line bleeding, and severe abdominal pain were among the most serious complications seen in this group. There was one death (0.8%) in this group, which occurred in a patient who had torsion and necrosis of the Roux limb. After reoperation and reconstruction of the gastrojejunostomy, the patient went into multisystem organ failure-and died on POD 7.

These and other studies [2, 18] show that the late postoperative complications after LAGB and RYGB are fairly different. Following lap band surgery, long-term complications were more common in our patients (17%), including pouch enlargement (12%), band slippage (2%), band erosion (0.2%), and port/ tubing complications (2.7%). Some of these problems decreased with experience (i.e., port/tubing complications); however, other complications such pouch enlargement occurred at a constant rate throughout the experience. Most likely this was correlated with the close follow-up and the routine performance of tailored adjustments. Indeed, this approach allowed us to successfully manage the majority of patients (77%) nonsurgically. Overall, 38 patients (8%) required a second operation. In 60% of them, the reason for reoperation was either pouch enlargement or band slippage. Band removal was necessary in seven patients (1%), six of whom requested the band to be removed and in one patient band removal was necessary due to band erosion. During the past 4 years, we have accumulated enough experience to realize that this procedure requires patient behavior modifications (e.g., diet compliance) to be successful since this procedure does not offer malabsorption or dumping syndrome.

The rate of late complications after RYGB was 14%. The most frequent incidents were marginal ulcer (3%), stomal stenosis (2%), and SBO (3%). The reoperation rate was 6% in this phase. The most common reason for reoperation was SBO; one patient had a retrocolic RYGB. Thus, the antecolic version is our preferred approach. All but one of these patients required a laparotomy to resolve the complication. As expected, complications in this group were more risky and in most cases the resolution could not be accomplished laparoscopically. Four additional patients developed microcytic anemia. No other nutrient deficiencies were observed. These significant adverse events and the fact that the operation results in a permanent modification of the gastrointestinal tract have made the lap band more attractive to our patients. The lap band is considered the least invasive surgical option, offering adjustability, usually reversibility, and almost no malnutrition risk. Even Mason, who initially described the gastric bypass, was concerned about these complications and opted for restrictive procedures to treat obesity [12].

Outcome of bariatric surgery

The goal of surgical treatment for obesity is to offer extremely obese patients long-lasting weight loss and resolution of its associated comorbid conditions [14]. Obesity should be managed with the least invasive approach to avoid increasing morbidity in a patient population with already high associated morbidity and mortality.

It is accepted that both surgical procedures (LAGB and RYGB) offer sustained weight loss in the majority of patients. The short- and medium-term data from U.S. RYGB series show an EWL of 55–77% [4, 9, 23, 27] compared to 53–56% EWL reported from Australia or Europe for LAGB [3, 17]. The results of this study do not diverge from those previously reported in the literature. In our practice, following gastric bypass, patients experienced a rapid initial weight loss, with 65% EWL at 12 months (Fig. 2). This weight loss remained unchanged at 2 and 3 years. As estimated, after lap band there was slower initial weight loss compared to that of gastric bypass, with the majority of patients achieving 39% EWL at 12 months and 55% EWL at 36 months. Additionally, with experience, we have identified that weight loss after lap band is strongly correlated with regular follow-up and band adjustments. However, after

RYGB, follow-up does not seem to affect weight loss, at least for the first 12–18 months after surgery.

Previous reviews have acknowledged that both LAGB and RYGB have an impact on comorbid conditions [16, 25]. This study demonstrates that if morbidly obese patients accomplish an adequate weight loss after obesity surgery, resolution or improvement of comorbidities are the logical end result (Fig. 3). However, LAGB seems to be safer than gastric bypass.

Conclusion

This study demonstrates that obesity surgery is an excellent method for sustained and effective long-lasting weight loss. LAGB is a simpler, less invasive, and safer procedure compared to RYGB. Despite the fact that the mean %EBWL in RYGB patients was higher than that in LAGB patients at all times, both procedures were equally effective at controlling comorbidities. Therefore, LAGB may perhaps be considered as the first alternative in the surgical armamentarium for the treatment of morbid obesity due its low morbidity, low mortality, and effectiveness in accomplishing weight loss. Randomized control trials comparing these therapeutic alternatives are needed to clarify this controversy.

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