Surg Endosc (2011) 25:292–297
DOI 10.1007/s00464-010-1176-x

Laparoscopic adjustable gastric banding (LAGB): surgical results and 5-year follow-up

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Received: 11 May 2009 / Accepted: 14 January 2010 / Published online: 22 July 2010

Abstract
Background LAGB is a technique increasingly used in the USA. The aim of this study is to analyze the 5-year outcome in terms of weight loss and complications.
Method We reviewed our prospective electronic database for all patients undergoing LAGB between 2002 and 2007. We assessed weight progression, complications, and reoperations.
Results We performed 199 cases during this period (70.4% females). Mean age was 37.8 ± 12.4 years. Preoperative body mass index (BMI) was 36.0 ± 3.8 kg/m^2. Preoperative comorbidities were dyslipidemia in 52.3%, insulin resistance in 30.7%, arterial hypertension in 24.6%, and type 2 diabetes in 5.5%. There were no conversions to open technique. Early complications were observed in two patients (1%): one hemoperitoneum and one ileitis. Mortality was 0%. Late complication rate was 33.6% (18.0% related to the band). Reoperation was required in 40 patients (20.1%). Laparoscopic repositioning was done in seven patients, and port/reservoir revision was done in five patients. Band removal was required in 28 patients, due to inadequate weight loss in 9, slippage in 9, gastric erosion in 1, bowel obstruction in 1, acute stomach dilatation in 1, and food intolerance in 7. Twenty of these patients underwent revisional surgery: sleeve gastrectomy in 12 and laparoscopic Roux-en-Y gastric bypass in 8 cases. Unrelated band complication was seen in 15.6%, mainly due to anemia (7.5%), alopecia (4.5%), and cholelithiasis (3.5%). With a median follow-up of 48 months (1–72 months), 75, 60, and 95% of patients were available for follow-up at 1, 3, and 5 years, respectively. Mean percent excess weight loss (%EWL) at 1, 3, and 5 years was 58.8 ± 30.0%, 56.8 ± 35.0%, and 58.4 ± 46.6%, respectively. However, failure rate (%EWL <50%) at 1, 3, and 5 years was 40.4, 43.5, and 46.3%, respectively.
Conclusions LAGB has low perioperative morbidity. However, its late complications are significant, and inadequate weight loss can be as high as 46.3% after 5 years.

Keywords Morbid obesity · Gastric banding · Weight loss failure · Bariatric surgery · Complications

Obesity has become a global health problem to the point of being the most important epidemic of our times [1, 2]. In Western countries the prevalence is over 20% in adult population, and in USA more than 30% [3]. Diseases such as coronary artery disease, hypertension, type 2 diabetes, and cancer have been associated with obesity, increasing general mortality rates [4].

Bariatric surgery has proven to be the only effective treatment for morbid obesity in terms of long-term weight reduction and resolution of comorbid conditions. It has also proven to reduce mortality rates in long-term follow-up [5, 6].

Laparoscopic gastric banding, first described in 1993, was the first minimally invasive surgery for obese population [7]. Since then, adjustable laparoscopic gastric banding (LAGB) has become an attractive, simple, reversible, and promising technique that has been adopted by many bariatric centers, especially in Europe and

Presented at the SAGES 2009 Annual Meeting, April 22–24, 2009, Phoenix, AZ.

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Australia [8]. In recent years, increasing interest has been observed in the USA due to the approval in 2001 of the Lap-Band® system. Being a restrictive and minimally invasive technique, it has many benefits based on low morbidity and mortality rates compared with other bariatric techniques [8, 9].

Early results were promising, with reasonable weight loss and low morbidity and mortality rates [7, 9]. However, few studies have been published with long-term (5-year) results. Available information has been contradictory; whereas some studies describe favorable long-term weight loss and low reoperation rate [10–14], others have observed a progressive decline in effectiveness over the years, with increased incidence of long-term complications such as erosion, food intolerance, and slippage. Many of these patients have required band removal [15–19]. Long-term results have to be carefully analyzed based on weight loss and resolution of comorbidities to determine whether LAGB has a future as a reasonable alternative for bariatric surgery.

The aim of this study is to determine long-term results of the patients undergoing LAGB in a high-volume academic center in terms of excess weight loss, success, failure, early and late complication rates, reoperations, and the need of revisional surgery.

Patients and methods

Patients

From September 2002 to November 2006, 199 patients underwent LAGB at the Department of Digestive Surgery of Pontificia Universidad Católica de Chile. Patients were offered LAGB after multiple failures of conservative treatment with a multidisciplinary team of the Obesity Surgery Center. All patients completed an evaluation from the nutriologist, psychologist, kinesiologist, dietician, and bariatric surgeon. After participation in the preoperative program they signed an informed consent before surgery. When necessary, other specialists (psychiatrist, cardiologist, pneumologist) were consulted as required.

Data was recorded in our prospective database and included all demographic information, as well as perioperative variables such as anthropometric data, comorbidities, surgical complications, and follow-up information. The latter included evolution of weight expressed as the percent excess weight loss (%EWL), BMI, late complications, reoperations, and need of band removal. Excess weight was calculated as total weight minus ideal weight (weight for BMI of 25 kg/m^2). Success was defined as an excess weight loss $\geq$50%. Failure was defined as an excess weight loss $<$50% after the first year.

Operative technique

Patients were placed in a supine–split leg position with reverse Trendelenburg position. Antibiotic prophylaxis (cefazolin 1 g iv) was given during anesthesia induction. Low-molecular-weight heparin was given after surgery during hospital stay. Pneumoperitoneum was established through an Optiview trocar (Ethicon Endosurgery. Cincinnati, OH, USA) to 15 mmHg pressure. A 30° scope was used for the procedure. We implanted the Lap-Band system (INAMED Health, formerly BioEnterics Corporation, Santa Barbara, CA) in 72 patients and the Swedish Adjustable gastric band (Ethicon Endo-Surgery, Cincinnati, USA) in 127, following the pars flaccid technique with five trocars. The liver was retracted with a 5-mm grasper, and the angle of his was dissected from the left crus. We then opened the pars flaccid a and created a retrogastric tunnel from the lower end of the right diaphragmatic crus to the angle of hiss using the "goldfinger" instrument (Obtech, Ethicon Endosurgery). The band was tested for proper function, inserted into the abdomen through a trocar site, and pulled through the retrogastric tunnel. The band was positioned around the stomach with the help of a 36-French calibration tube with a balloon filled to 20 cc to ensure a proximal pouch. The device was closed and secured. Gastro-gastric sutures with nonabsorbable material were placed on the anterior aspect of the stomach to prevent slippage. The connecting tube was pulled out through the left flank port. The port reservoir was fixed to the abdominal fascia with four nonabsorbable sutures.

Follow-up protocol

Patients were kept on a liquid diet for the first 7 days and then a puree diet for 3 weeks. The band system was not filled until postoperative day 30, when it was adjusted under radiographic guidance. Thereafter, adjustments were performed at the outpatient clinic, depending on clinical condition at 3, 6, 9, and 12 months. Clinical follow-up examination included anthropometric measurements, dietary counseling, and evolution of comorbid conditions. Additional radiologic or endoscopic studies were performed whenever patients reported symptoms suggesting complications. Vitamin supplementation was prescribed for 6 months and whenever indicated thereafter.

Results

From September 2002 to November 2006, 199 patients underwent LAGB. Mean age was 37.8 $\pm$ 12.4 years; 140

Table 1 Preoperative demographics data on 199 patients undergoing LAGB

Characteristic	Mean	Range
Age (years)	37.8 ± 12.4	15–70
Gender		
Female	140	70.4%
Male	59	29.6%
Weight (kg)	100.0 ± 16.1	74–150
BMI (kg/m^2)	36.0 ± 3.8	30.1–50.8
EW (kg)	30.7 ± 11.5	13.4–68.1

Table 2 Preoperative comorbidities

Preoperative comorbidities	*n* (%)
Dyslipidemia	104 (52.3)
Insulin resistance	61 (30.7)
Hypertension	49 (24.6)
Fatty liver disease	31 (15.6)
Type 2 diabetes	11 (5.5)
Sleep apnea	9 (4.5)

Table 3 Surgical variables

Characteristic	Mean	Range (%)
Operative time (min)	70.9 ± 22.5	35–150
Hospital stay (days)	1.8 ± 0.8	1–4
Early complications	2	1.0%
Late complications	67	33.6%
Conversion	0	
Early reoperations	1	0.5%
Mortality	0	

(70.4%) were female and 59 (29.6%) were male. Preoperative BMI was 36.0 ± 3.8 kg/m^2 (Table 1). Patients had multiple comorbidities as presented in Table 2: dyslipidemia in 104 (52.3%), arterial hypertension in 49 (24.6%), insulin resistance in 61 (30.7%), type 2 diabetes in 11 (5.5%), and sleep apnea in 9 (4.5%). Mean duration of surgery was 70.9 ± 22.5 min (range 35–150 min), and hospital stay was 1.8 ± 0.8 days (range 1–4 days). All patients underwent a laparoscopic approach and there was no conversion to open surgery (Table 3).

Two patients developed early complications (1%). One had a hemoperitoneum 24 h after surgery and required reoperation by laparoscopy. Bleeding from a 5-mm port was identified. The patient was discharged 3 days after surgery. The second patient developed progressive abdominal pain, and a computed tomography (CT) scan confirmed distal ileitis. He was treated with intravenous antibiotics. There was no mortality in this series.

Table 4 Late complications (>30 days)

	N	%
Related to the band	*36*	*18.0*
Slippage	12	6.0
Port dysfunction	8	4.0
Food intolerance	13	6.5
Band erosion	1	0.5
Bowel obstruction	1	0.5
Port infection	1	0.5
Not related to the band	*31*	*15.6*
Anemia	15	7.5
Alopecia	9	4.5
Cholelithiasis	7	3.5
Total	67	33.6

Median follow-up of this group of patients was 48 months (1–72 months), with follow-up at 1, 3, and 5 years of 75, 60, and 95%, respectively. We observed late complications in 67 patients (33.6%). Of these, 36 (18%) had complications related to the band, such as slippage in 12 (6%), port dysfunction in 8 (4%), food intolerance in 13 (6.5%), band erosion in 1 (0.5%), and port infection in 1 patient (0.5%) (Table 4).

Forty (20%) patients required reoperation during follow-up. Seven bands had to be repositioned, and five band systems required port revision. Band removal was necessary in 28 patients (14%), due to insufficient weight loss in 9, slippage in 9, food intolerance in 7, erosion in 1, bowel obstruction in 1, and acute gastric dilatation in 1 (Table 5).

Table 5 Causes for reoperation

Cause	*N*	%
Band repositioning		
Slippage	3	1.5
Port disconnection	3	1.5
Leaks connector	1	0.5
Port revision		
Port dysfunction	4	2.0
Port infection	1	0.5
Band removal		
Slippage	9	4.5
Inadequate weight loss	9	4.5
Band erosion	1	0.5
Bowel obstruction	1	0.5
Acute dilation stomach	1	0.5
Food intolerance	7	3.5
Total	40	20

Of these patients, 20 underwent revisional surgery: 12 were converted to sleeve gastrectomy and 8 to gastric bypass. Long-term complications not related to the band are shown in Table 4.

Weight loss evolution is presented in Fig. 1. BMI at year 1, 2, 3, 4, and 5 was 29.9 ± 3.9, 29.8 ± 3.9, 30.1 ± 4.4, 29.8 ± 4.6, and 29.9 ± 5.4 kg/m^2, respectively (Fig. 1). Percent excess weight loss at 1, 3, and 5 years was 58.8 ± 30.0%, 56.8 ± 35.0%, and 58.4 ± 46.6%, respectively (Figs. 2, 3). However, if we consider the patients who did not achieve 50% excess weight loss, the failure rate at 1, 3, and 5 years was 40.4, 43.5, and 46.3%, respectively (Table 6). Evolution of comorbidities is presented in Table 7.

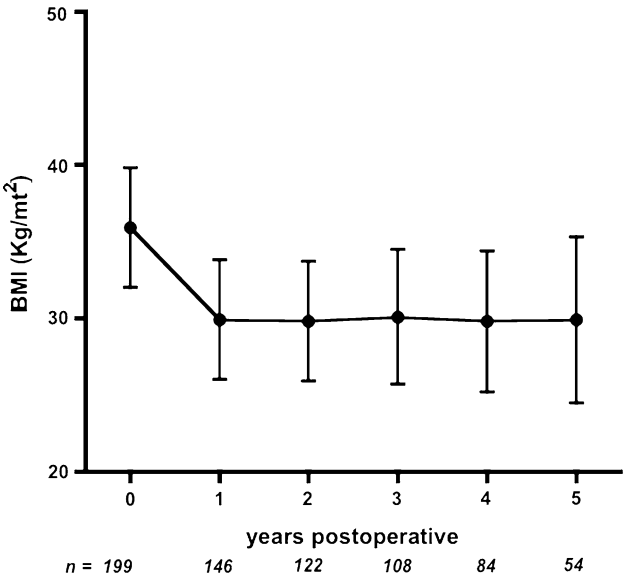

Fig. 1 Weight loss (BMI). Mean ± SD. *N*: patients available for follow-up

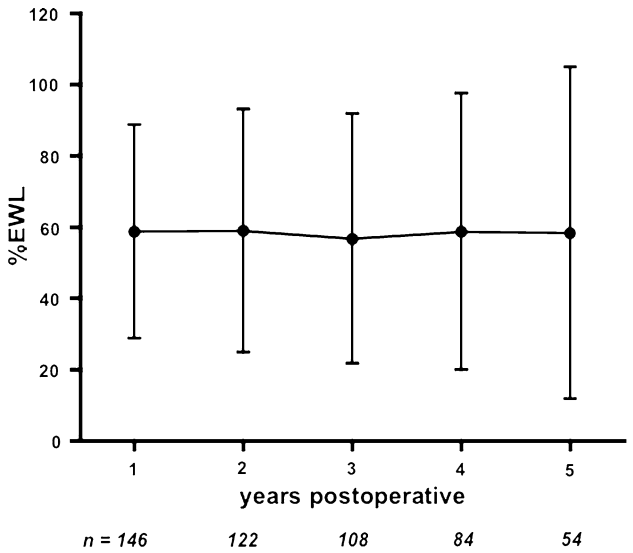

Fig. 2 Weight loss (%EWL). Mean ± SD. *N*: patients available for follow-up

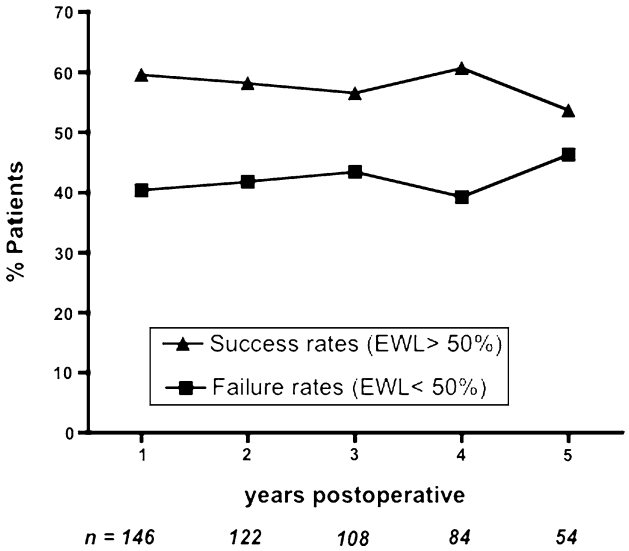

Fig. 3 Success and failure rates in 199 patients undergoing LAGB

Discussion

Obesity has become a global health problem, affecting today more than 1.7 billion people worldwide [20]. In Chile, the 2003 National Health Report confirmed the high prevalence of obesity among adult population, similar to the rates observed in other Western countries: 38% overweight, 22% obese, and 1.3% morbid obesity [21].

The introduction of LAGB in 1993 has played an important role in the development of bariatric surgery. This procedure appeared to be very promising and had the ideal advantages of a real minimally invasive procedure: low morbidity and short learning curve, so it was rapidly adopted by many bariatric groups, especially in Europe and Australia [7], being the most common bariatric procedure performed in recent years.

LAGB was introduced in Chile in 2001. With substantial experience in gastric bypass, the surgical community rapidly adopted this new technique. Initial results were very good in terms of morbidity and mortality [22]. Larger series also showed all the short-term advantages of a minimally invasive, reversible, and adjustable technique. Angrisani [9] published the Italian experience in 1,265 patients with no mortality and good initial weight loss. O'Brien [23] described the Australian experience in 1,120 patients with no mortality and 1.5% perioperative complications.

In our experience in 199 patients we had similar initial results with very low morbidity rate (1%) and no conversion to open surgery or mortality.

Table 6 Weight loss, reoperation rate, and EWL <50%

Years	1	2	3	4	5
Follow-up, *n* (%)	146 (75)	122 (62)	108 (60)	84 (56)	54.3 (95)
BMI (kg/m^2)	29.9 ± 3.9	29.8 ± 3.9	30.1 ± 4.4	29.8 ± 4.6	29.9 ± 5.4
EWL (%)	58.8 ± 30.0	59.0 ± 34.1	56.8 ± 35.0	58.8 ± 38.8	58.4 ± 46.6
Reoperations, *n* (%)	10 (25)	3 (7.5)	11 (27.5)	7 (17.5)	9 (22.5)
Successes, *n* (%)	87 (59.6)	71 (58.2)	61 (56.5)	51 (60.7)	29 (53.7)
Failures, *n* (%)	59 (40.4)	51 (41.8)	47 (43.5)	33 (39.3)	25 (46.3)

Table 7 Evolution of comorbidities

Variables	Resolution (%)	Better control (%)	Total (%)
Dyslipidemia	20.5	36.3	56.8
Insulin resistance	42.8	19.0	61.8
Hypertension	21.7	39.1	60.8
Fatty liver disease	55.5	11.1	66.6
Type 2 diabetes	0.0	28.6	28.6
Sleep apnea	75.0	25.0	100.0

Belachew first reported in 350 patients some complications related to food intolerance in 11.7% [24]. Chapman, in a systematic review [8], confirmed that LAGB was safer than vertical banded gastroplasty and Roux-en-Y gastric bypass in terms of early complication rates and mortality. In a meta-analysis, Buchwald [25] compared 30-day mortality rates for different techniques, observing a significant difference: 0.1% for LAGB, 0.5% for gastric bypass, and 1.1% for biliopancreatic diversion. In our own experience we have also observed a significant difference in early morbidity rates when comparing gastric bypass and LAGB.

Long-term complication rates have recently been described in several papers and depend on the follow-up. In recent publications more authors are reporting a rise in late complication and reoperation rates [17]. In our series with median follow-up of 48 months, we observed a 33.6% long-term complication rate with 20% requiring reoperation. Tolonen [17] described a 19.6% major complication rate in 250 patients with a 5-year follow-up, mostly band leakage (9.8%), slippage (6.5%), and erosion (3.3%). They described a 24.4% major reoperation rate. Suter [19] had a 33.1% long-term complication rate in 317 patients with 81.5% follow-up after 7 years, and 21.7% of the patients required major reoperation. In our series 18% of long-term complications were related to the band, and 28 patients (20%) required band removal, due mainly to slippage and inadequate weight loss. We had a low rate of erosion compared with other long-term follow-up series [18], mainly because we always performed the pars flaccid a technique. Balsinger [16] also described an 18% long-term complication rate with mean follow-up of 63 ± 2 months in 196 patients. In this series band migration was also 1%. However 32% of patients required major reoperations: 18% band replacement and 14% band removal. Silecchia [26], with follow-up of 3.2 years, described a 17.6% reoperation rate in the long term, mainly due to pouch dilatation and insufficient weight loss.

Weight loss has been one of the main issues in the long-term follow-up of LAGB. Reports on follow-up tend to be difficult to analyze, considering that many authors report very reasonable mean excess weight loss on follow-up, but when data are analyzed carefully, there is a group of responders with very good EWL and others with very poor results [14, 27]. In our study, for example, we observed 58.4% EWL after 5 years, but only 53.7% of patients achieved 50% EWL. Other difficulties in reports have been that some authors have changed the definition of failure [14, 27, 28]. In our study we considered 50% EWL as the standard of care to consider the procedure a success. Therefore, patients not achieving this standard were considered failures. In our study only 53.7% of patients were considered a success after 5 years, and 46.3% were failures.

Tolonen [17] found similar results to our series, with only 35% of the patients achieving 50% EWL after 8 years.

Comorbidities have been reported in some studies [29]. Weight loss during the first year has been associated with resolution of many obesity-related diseases [30]. In our study we observed 56% better control or resolution of dyslipidemia, 60.8% for arterial hypertension, and 53.6% for diabetes. However resolution rates of many comorbid conditions have been much lower than reported for other bariatric techniques [25]. On the other hand, assessment of these conditions has usually been performed 1 year after surgery, when patients achieve maximum weight loss. Long-term resolution of comorbidities is mandatory to establish the role of this technique and its ability to recover metabolic conditions.

In conclusion, LAGB has proven to be a safe and minimally invasive procedure. Although early results appeared to be promising, long-term results have shown low success rate and high complication and reoperation

rates. With almost 50% of patients not achieving 50% EWL and the inability at the moment to consistently predict the best candidates, we have abandoned the use of this technique as an option for our bariatric armamentarium.

Disclosures Drs. Camilo Boza, Cristian Gamboa, Gustavo Perez, Fernando Crovari, Alex Escalona, Fernando Pimentel, Alejandro Raddatz, Sergio Guzman, Luis Ibáñez have no conflicts of interest or financial ties to disclose.

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