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Surgery for Obesity and Related Diseases 14 (2018) 780–784

SURGERY FOR OBESITY AND RELATED DISEASES

Original article

# Adjustable gastric banded plication versus sleeve gastrectomy: the role of gastrectomy in weight loss

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Received January 2, 2018; accepted January 29, 2018

**Abstract**

**Background:** Laparoscopic adjustable gastric banded plication (LAGBP) is a procedure that has a stomach volume similar to the sleeve gastrectomy (SG). It has shown promising results but has not been adopted widely.

**Objective:** To determine the difference gastrectomy has on weight loss and complications.

**Setting:** Private practice, United States.

**Methods:** A retrospective, matched-cohort analysis of LAGBP and SG patients was found through matching body mass index and sex for each LAGBP to a SG patient. Body mass index, percentage excess weight loss, and total weight loss percentage were analyzed. Complication data were also collected on a short- (<30 d) and long- (>30 d) term basis. Complication rates were then compared. Data were analyzed through descriptive statistics.

**Results:** Patients who received SG lost more body mass index, percentage excess weight loss, and total weight loss percentage at 1 year and started to gain weight between 1 and 2 years. LAGBP patients weight loss also peaked at 1 year but maintained their weight loss to year 2. SG patients lost more weight at all time points, and the difference was statistically significant ($P < .05$). LAGBP and SG patients had statistically similar rates of short- and long-term complication rates. In the LAGBP group (57 patients) 5, 9, 13, 14, 14, and 17 patients were lost to follow-up at 3, 6, 9, 12, 18, and 24 months, respectively. In the SG group (57 patients) 11, 10, 11, 13, 20, and 29 patients were lost to follow-up at 3, 6, 9, 12, 18, and 24 months, respectively.

**Conclusion:** Both procedures have peak weight loss at 1 year with acceptable complication rates. However, the SG starts to regain weight while the LAGBP shows weight stability. More time is needed to see if the weight loss curves will intersect or if the late band complications will also happen with the LAGBP as they have with band placement without plication. (Surg Obes Relat Dis 2018;14:780–784.)


*Keywords:* Lap band; Gastric plication; Imbrication; Sleeve gastrectomy; Adjustable gastric banded plication

The gastric plication was recently developed as another procedure to help cure the problems of morbid obesity. It held promise of good weight loss results with few complications. It did not introduce any foreign bodies or remove anything. It was theoretically reversible and much less expensive than other bariatric procedures. However, it was not a widely adopted due to skepticism about these claims.

To help increase the sustained weight loss of the gastric plication, many surgeons added the adjustable gastric band [1]. The laparoscopic adjustable gastric band with plication (LAGBP) procedure promised to increase the weight loss of plication alone and be comparable in results to the laparoscopic sleeve gastrectomy (SG). The LAGBP has also been shown to decrease band complication rates [2].

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https://doi.org/10.1016/j.soard.2018.01.040
1550-7289/

This purpose of our study was to add to the current literature about the LAGBP and to test the comparability of the SG in terms of weight loss and complications.

## Methods

All patients who had the LAGBP or SG at a single private practice institution between 2011 and 2014 were included in this study. Patients signed a consent to have their data analyzed in a blinded fashion. They also signed a specific consent to have the LAGBP or SG. Institutional review board approval for this study was obtained from the Quorum institutional review board, study number 31353.

All available LAGBP patients were blindly matched to an SG patient by sex and body mass index (BMI; within .5 point). This allowed for matched cohort analysis between these 2 procedures. Patients were considered for comparison only if these procedures were primary; revisionary procedures were excluded.

All SGs were done by 3 surgeons with similar techniques at a single practice. All LAGBP were done by 1 surgeon in the same practice.

The SG is done by stapling alongside a 40-Fr bougie placed on the lesser curvature of the stomach. No patient in this study had the staple line oversewn or reinforced. The staple line in all patients was started approximately 5 cm from the pylorus and ended at the angle of His. Each patient had a visual inspection of hiatus to evaluate for hiatal hernia with simultaneous repair if a defect was found.

The method used for band placement has also been described in detail [3]. Briefly, after placement of 4 trocars and a liver retractor, a calibration tube is introduced into the stomach to check for the presence of a hiatal hernia. Any hernias seen are repaired at that time, as per the routine of the operating surgeons.

Once this was accomplished, the angle of His was bluntly dissected, the pars flaccida was then entered, and a retro gastric tunnel was dissected. Using the band passer, the band (Allergan/Inamed, Ireland) was brought through the dissected tunnel and locked into place. Gastrogastric sutures were used to affix the band to the anterior stomach wall. An additional anterior stitch was also placed to prevent slippage.

Gastric plication technique used in this procedure has been described in detail previously [4]. Briefly, once the plication has been performed, the lap band is passed as if there has been no plication done. This is done to maximize satiety through reduction in stomach size and ability to pass food through the stomach. The only modification of our technique relates to the elimination of the gastrogastric plication sutures to hold the band in place. The tubing was then grasped and brought out through a lateral port site with or without tunneling. The port was tacked to the anterior rectus fascia using tacking sutures.

Patients were followed up with the same multidisciplinary program. This program includes nutritional counseling, support groups, and exercise training. At every follow-up appointment, patients were tracked for weight and BMI. The only difference between the 2 procedures' follow-up was the need for band fills in the LAGBP group. Patients were told to return at 1, 3, and 6 months and then every 3 months after for fills. All band adjustments were done under fluoroscopic guidance to guide fill accuracy.

A nonlinear regression analysis was run for weight loss values at 3, 6, 9, 12, 18, and 24 months for each individual patient. Regressions were run to interpolate weight loss at 3, 6, 9, 12, 18, and 24 months because most patients do not come in at that exact time frame. Regression estimates for each patient were only used if the $r^2$ value from the regression was $>.95$ (this means that 5% is not explained by passage of time since surgery but by extraneous variables). Calculations were then made from these time points with means and standard deviations to compare percentage excess weight loss, BMI, and percentage total weight loss. T tests were used to describe the difference between the data at each time point for each value measured.

Complications and rates were also gathered and divided into those that occurred within 30 days (short term) and after 30 days (long term). Complication rates were then compared using $\chi 2$ tests.

All statistics were run through SigmaPlot software (SigmaPlot, Systate Software, Inc.).

## Results

One hundred four patients met the inclusion criteria for this study (57 for each procedure). The average BMI, weight, and age, as well as the proportions of sexes and co-morbidities in this study are recorded in Table 1. Because patients were matched for sex and BMI, there was no difference in these. The only statistically significant difference between the 2 groups was age. LAGBP patients were significantly older than SG patients. In the LAGBP group 5, 9, 13, 14, 14, and 17 patients were lost to follow-up at 3, 6, 9, 12, 18, and 24 months, respectively. In the SG group 11, 10, 11, 13, 24, and 38 patients were lost to follow-up at 3, 6, 9, 12, 18, and 24 months, respectively.

According to percentage excess weight loss, BMI, and percentage total weight loss measures, SG patients lost statistically significantly more weight than LAGBP patients at 3, 6, 9, 12, 18, and 24 months ($P < .05$; Table 2).

The weight loss velocity or weight loss between follow-up points is greater for SG until 9 months; the weight loss velocity then is greater for the LAGBP for the rest of the time points measured.

Complication rates with Clavien-Dindo classifications are found in Table 3. Clavien-Dindo Class III-b complication rates were 12.2% for LAGBP and 7% for SG, and the

Table 1
Demographic and co-morbidity data for patient groups

| | LAGBP | SG | *P* value |
|---|---|---|---|
| N | 57 | 57 | |
| Male/female | 10/47 | 10/47 | 1 |
| Weight, lb | 267.9 ± 50.7 | 274.9 ± 47.7 | .279 |
| Age, yr | 50.5 ± 12.5 | 43.9 ± 10.9 | .004 |
| BMI, kg/m$^2$ | 43.6 ± 6.5 | 43.5 ± 6.4 | .946 |
| Sleep Apnea | 26 (46%) | 25 (44%) | .979 |
| Diabetes | 14 (25%) | 17 (30%) | .674 |
| GERD | 25 (44%) | 29 (51%) | .574 |
| Hypertension | 29 (51%) | 26 (46%) | .708 |

LAGBP = laparoscopic adjustable gastric banded plication; SG = sleeve gastrectomy; BMI = body mass index; GERD = gastroesophageal reflux disease.

Data are presented as mean ± standard deviation or proportion of patients with co-morbidity.

differences were not statistically different. Clavien-Dindo Class III-a complication rates were 5% for LAGBP and 7% for SG, and these were not statistically different. Clavien-Dindo Class I short- and long-term complication rates were 9% and 7% for LAGBP, respectively, and 5% and 7% for SG, respectively, and these differences were not statistically different.

The majority of Clavien-Dindo Class III-b complications in LAGBP patients came from the band itself. Four patients had the band removed, and 3 patients had their ports replaced. Of those who had the band removed, 3 were revised to normal anatomy and 1 was revised to a duodenal switch. Two patients were revised due to insufficient weight loss, 1 to a Roux-en-Y gastric bypass and the other to a duodenal switch.

A variety of SG patients had Clavien-Dindo Class III-b complications. One patient had an exploratory laparoscopy to find a bowel obstruction. One patient had worsening gastroesophageal reflux disease that led to the sleeve being redone. One other patient had a postoperative bleed that led to oversewing the bleed. Two patients had hernia repairs after the surgery. No SG patients were revised to different procedures.

## Discussion

The main purpose of our study was to determine how much of an impact gastrectomy makes on weight loss. Another purpose of this study was to add to our previous study of the differences between plication alone versus the SG [4]. Because the previous study population was small and the groups were not matched, the determination was made to match patients with similar stomach-sized procedures, SG and LAGBP. This was done by matching same sexes and similar BMIs. After the development of these matched cohorts, differences were analyzed to determine their effect on outcomes.

The only difference that could potentially skew our results is the difference in the ages of the patients undergoing these procedures. Age has been reported to reduce average weight loss [5–8]. To account for this difference, we performed a multivariate analysis and found that age was not a statistically significant predictor of the differences between the 2 procedures.

One thing seen by this study is that weight loss is not simply about constricting the stomach. Our study shows that there is a lot more taking place inside the stomach that promotes weight loss. Many advocates of the conclusions point to hormones in the stomach, such as ghrelin, but a wide variety of conclusion are found in the literature about the role of hormones on weight loss [9–13]. Our study does not try to state the role of hormones in the stomach in weight loss. Our study simply shows that something more is involved beyond restricting stomach size.

The reason the LAGBP would be a preferable operation over the SG would be the ability to reverse the procedure if required. However, many say the LAGBP is a riskier operation than the SG due to the addition of a foreign body with the band. However, complication rates were statistically significantly similar to each other in all types of Clavien-Dindo classifications. Yet, we cannot help but agree with those criticizing this approach because the band tends to slip an average of 3 years after placement, and this

Table 2
Weight loss analysis between SG and LAGBP

| | N | | %EWL | | BMI | | %TWL | |
|---|---|---|---|---|---|---|---|---|
| Mo | SG | LAGBP | SG | LAGBP | SG | LAGBP | SG | LAGBP |
| 0 | 57/57 (100%) | 57/57 (100%) | 0% | 0% | 43.5 ± 6.4 | 43.6 ± 6.5 | 0% | 0% |
| 3 | 46/57 (81%) | 52/57 (91%) | 44.6% ± 13.3% | 28% ± 12.2% | 36.1 ± 5.7 | 38.8 ± 5.8 | 18% ± 4.1% | 11.3% ± 5.4% |
| 6 | 47/57 (82%) | 48/57 (84%) | 61.7% ± 20.6% | 36.4% ± 14% | 33 ± 6 | 37 ± 5.4 | 24.9% ± 6.3% | 14.7% ± 5.9% |
| 9 | 46/57 (81%) | 44/57 (77%) | 67.7% ± 19.5% | 41.3% ± 17.5% | 31.9 ± 5.7 | 36.2 ± 5.5 | 27.8% ± 6.7% | 16.1% ± 6.3% |
| 12 | 44/57 (77%) | 43/57 (75%) | 71.1% ± 22.1% | 44.9% ± 19.2% | 31.3 ± 5.9 | 35.3 ± 5.2 | 29.3% ± 7.9% | 17.5% ± 7.1% |
| 18 | 37/57 (65%) | 43/57 (75%) | 72.4% ± 22% | 47.8% ± 21.2% | 31.1 ± 5.9 | 34.6 ± 5.2 | 30.7% ± 8.8% | 18.7% ± 8.1% |
| 24 | 28/57 (49%) | 40/57 (70%) | 67.2% ± 25.7% | 45.9% ± 25.3% | 32 ± 6.1 | 35.1 ± 5.6 | 28.4% ± 10.1% | 17.8% ± 9.3% |

%EWL = percentage excess weight loss; BMI = body mass index; %TWL = percentage total weight loss; LAGBP = laparoscopic adjustable gastric banded plication; SG = sleeve gastrectomy.

Months since procedure. Data presented as averages ± standard deviations. Proportions are presented as amount of people that have come in at that time point compared to how many are available for follow up at that point. Only initial (mo 0) is not statistically significantly different.

Table 3
Short- and long-term complications of each procedure

| Short-term complications (<30 d) | | | | Long-term complications (>30 d) | | | |
|---|---|---|---|---|---|---|---|
| LAGBP | | SG | | LAGBP | | SG | |
| Class I port pain | 2 | Class I nausea | 3 | Class I nausea | 3 | Class I nausea | 3 |
| Class I diarrhea | 1 | Class I diarrhea | 1 | Class IIIa nausea | 2 | Class IIIa nausea | 4 |
| Class I constipation | 1 | Class I vomiting | 1 | Class IIIb nausea | 1 | Class I vomiting | 2 |
| Class I abdominal pain | 1 | Class IIIb postoperative bleed | 1 | Class I vomiting | 3 | Class IIIa vomiting | 3 |
| | | | | Class IIIa vomiting | 2 | Class I worsened GERD | 2 |
| | | | | Class IIIb vomiting | 1 | Class IIIb worsened GERD | 1 |
| | | | | Class IIIb port peak | 2 | Class I abdominal pain | 1 |
| | | | | Class IIIa abdominal pain | 1 | Class IIIa abdominal Pain | 1 |
| | | | | Class IIIb abdominal pain | 1 | Class IIIb abdominal pain | 1 |
| | | | | Class IIIb band slip | 1 | Class IIIa linear ulcer | 1 |
| | | | | Class IIIb flipped port | 1 | Class IIIb ventral hernia | 1 |
| | | | | Class I port pain | 1 | Class IIIb hiatal hernia | 1 |
| | | | | Class IIIa gastroparesis | 1 | Class IIIb small bowel obstruction | 1 |
| | | | | Class I band intolerance | 1 | Diagnostic EGDs | 3 |
| | | | | Class IIIb pleural effusion | 1 | EGD with dilation | 1 |
| | | | | Class IIIb splenic abscess | 1 | | |
| | | | | Class IIIb peritoneal abscess | 1 | | |
| | | | | Class IIIb kink in tubing | 1 | | |
| | | | | EGD | 3 | | |
| | | | | Overall patients with class IIIb complications | 7 | Overall patients with class IIIb complications | 4 |

LAGBP = laparoscopic adjustable gastric banded plication; SG = sleeve gastrectomy; EGD = esophagogastroduodenoscopy; GERD = gastroesophageal reflux disease.

Data presented as number of patients with a particular complication in long versus short term. Classifications are done according to the Clavien-Dindo Classification system.

study was only 3 years long. Hence, we believe the band complications at 5 years will be greater.

Due to the wide deviations in weight loss of SG [14], a procedure with less variable results is potentially intriguing. Long-term data are needed to see if LAGBP maintains weight loss better than SG alone. Additionally, other studies suggest that at 2 years the difference between the 2 procedures becomes no longer statistically significantly different [15,16]. We are planning on doing this study in the future to see the results at 5 years.

Our use of nonlinear regressions allowed our comparisons to be more accurate and to obtain the best comparison possible. Because most patients do not come into the clinic for follow-up points at the exact time intervals needed for an accurate comparison, using linear regressions for each patient's weight loss allowed us to interpolate their weight loss for those exact time points. This allowed us to pinpoint with some surety what their weight was at exactly 3, 6, 9, 12, 18, and 24 months without having them come in at those exact time points. This use of statistical analysis allows our study to compare the data without having to exclude patient data that do not fit exactly into the 3-, 6-, 9-, 12-, 18-, and 24-month follow-up points. With these data, we show that our results mirror weight loss percentages reported for both the SG and the LAGBP in previously published series [17–23].

Another limitation is the smaller follow-up percentages with the SG group. This probably relates to the higher follow-up rates in band patients as they need more frequent visits for fills. This small group may have caused our results to be skewed toward a larger percentage of successful SG patients. We tried to correct the skew by blinding our selection process of matching; this blinding allowed us to have a closer to perfectly random selection process. However, even with these corrections we cannot perfectly correct problems in retrospective analysis. Our small follow-up percentage beyond 1 year may skew our results, but we feel that those SG patients who did follow-up represent the rest of the group as a population. Patients lost to follow-up patients and those who continue to follow-up have been shown to have no statistical difference in outcomes [24].

## Conclusion

Our matched-cohort analysis clearly shows that SG gives better 1- and 2-year weight loss results than LAGBP. Additionally, both procedures have maximal weight loss by 1 year. However, SG patients begin to gain weight from 1 to 2 years while the LAGBP remains weight stable. Complication rates are similar, with the caveat that bands tend to have more complications after 2 years than sleeve. Both procedures appear

safe at 2 years. Further studies will need to be conducted to compare if the weight loss curve converge by 5 years.

## Disclosures

*Daniel Cottam is a trainer and speaker for Medtronic.*

## References


[1] Huang CK, Lo CH, Shabbir A, Tai CM. Novel bariatric technology: laparoscopic adjustable gastric banded plication: technique and preliminary results. Surg Obes Relat Dis 2012;8(1):41–5.

[2] Hussain A, Mahmood H, El-Hasani S. Gastric plication can reduce slippage rate after laparoscopic gastric banding. JSLS 2010;14 (2):221–7.

[3] Cottam DR, Atkinson J, Anderson A, Grace B, Fisher B. A Case-controlled matched-pair cohort study of laparoscopic Roux-en-Y gastric bypass and Lap-Band® patients in a single US center with three-year follow-up. Obes Surg 2006;16(5):534–40.

[4] Sharma S, Narwaria M, Cottam DR, Cottam S. Randomized double-blinded trial of laparoscopic gastric imbrication v laparoscopic sleeve gastrectomy at a single Indian institution. Obes Surg 2015;25 (5):800–4.

[5] Martin DJ, Lee CM, Rigas G, Tam CS. Predictors of weight loss 2 years after laparoscopic sleeve gastrectomy. Asian J Endosc Surg 2015;8(3):328–32.

[6] Rodríguez-Otero Luppi C, Balagué C, Targarona EM, et al. Laparoscopic sleeve gastrectomy in patients over 60 years: impact of age on weight loss and co-morbidity improvement. Surg Obes Relat Dis 2015;11(2):296–301.

[7] Contreras JE, Santander C, Court I, Bravo J. Correlation between age and weight loss after bariatric surgery. Obes Surg 2013;23(8):1286–9.

[8] Aslaner A, Öngen A, KoŞar M, et al. Relation between weight loss and age after laparoscopic sleeve gastrectomy. Eur Rev Med Pharmacol Sci 2015;19(8):1398–402.

[9] Couce ME, Cottam D, Esplen J, Teijeiro R, Schauer P, Burguera B. Potential role of hypothalamic ghrelin in the pathogenesis of human obesity. J Endocrinol Invest 2006;29(7):599–605.

[10] Cocue Me, Cottam D, Esplen J, Schauer P, Burguera B. Is ghrelin the culprit for weight loss after gastric bypass surgery? A negative answer. Obes Surg 2006;16(7):870–8.

[11] Kumbhari V, Oberbach A. Is excision of the gastric mucosa responsible for the superior outcomes of sleeve gastrectomy compared with gastric plication? Surg Obes Relat Dis 2015;11(3):732.

[12] Langer FB, Reza Hoda MA, Bohdjalian A, et al. Sleeve gastrectomy and gastric banding: effects on plasma ghrelin levels. Obes Surg 2005;15(7):1024–9.

[13] Kotidis EV, Koliakos G, Papavramidis TS, Papavramidis ST. The effect of biliopancreatic diversion with pylorus-preserving sleeve gastrectomy and duodenal switch on fasting serum ghrelin, leptin and adiponectin levels: is there a hormonal contribution to the weight-reducing effect of this procedure? Obes Surg 2006;16(5):554–9.

[14] Brethauer SA, Hammel JP, Schauer PR. Systematic review of sleeve gastrectomy as staging and primary bariatric procedure. Surg Obes Relat Dis 2009;5(4):469–75.

[15] Lee WJ, Lee KT, Ser KH, Chen JC, Tsou JJ, Lee YC. Laparoscopic adjustable gastric banding (LAGB) with gastric plication: short term results and comparison with LAGB alone and sleeve gastrectomy. Surg Obes Relat Dis 2015;11(1):125–30.

[16] Ahluwalia JS, Chang PC, Tai CM, Tsai CC, Sun PL, Huang CK. Comparative study between laparoscopic adjustable gastric banded plication and sleeve gastrectomy in moderate obesity-2 year results. Obes Surg 2016;26(3):552–7.

[17] Baltasar A, Serra C, Pérez N, Bou R, Bengochea M, Ferri L. Laparoscopic sleeve gastrectomy: a multi-purpose bariatric operation. Obes Surg 2005;15(8):1124–8.

[18] Serra C, Pérez N, Bou R, Bengochea M, Martínez R, Baltasar A. Laparoscopic sleeve gastrectomy. A bariatric procedure with multiple indications [in Spanish]. Cir Esp 2006;79(5):289–92.

[19] Thereaux J, Corigliano N, Poitou C, Oppert JM, Czernichow S, Bouillot JL. Comparison of results after one year between sleeve gastrectomy and gastric bypass in patients with BMI ≥ 50 kg/m². Surg Obes Relat Dis 2015;11(4):785–90.

[20] Cottam D, Qureshi FG, Mattar SG, et al. Laparoscopic sleeve gastrectomy as an initial weight loss procedure for high risk patients with morbid obesity. Surg Endosc 2006;20(6):859–63.

[21] Ahluwalia JS, Kuo HC, Chang PC, Sun PL, Hung KC, Huang CK. Standardized technique of laparoscopic adjustable gastric banded plication with 4-year results. Obes Surg 2015;25(9):1756–7.

[22] Huang CK, Chhabra N, Goel R, Hung CM, Chang PC, Chen YS. Laparoscopic adjustable gastric banded plication: a case-matched comparative study with laparoscopic sleeve gastrectomy. Obes Surg 2013;23(8):1319–23.

[23] Chaudhry UI, Osayi SN, Suzo AJ, Noria SF, Mikami DJ, Needleman BJ. Laparoscopic adjustable gastric banded plication: case-matched study from a single U.S. center. Surg Obes Relat Dis 2015;11 (1):119–24.

[24] Hunter Mehaffey J, Turrentine FE, Miller MS, Schirmer BD, Hallowell PT. Roux-en-Y gastric bypass 10-year follow-up: the found population. Surg Obes Relat Dis 2016;12(4):778–82.