



Bariatric

Heterogeneity of weight loss after gastric bypass, sleeve gastrectomy, and adjustable gastric banding



Dan Azagury, MD, Tara E Mokhtari, MD, Luis Garcia, MS, BA, Ulysses S Rosas, MD, Trit Garg, MD, Homero Rivas, MD, MBA, FACS, John Morton, MD, MPH, FACS, FASMBS*

Section of Bariatric and Minimally Invasive Surgery Stanford University School of Medicine, Stanford, CA

ARTICLE INFO

Article history:

Accepted 21 August 2018

Available online 11 October 2018

ABSTRACT

Background: Laparoscopic Roux-en-Y gastric bypass, laparoscopic sleeve gastrectomy, and laparoscopic adjustable gastric banding all lead to substantial weight loss in obese patients. Long-term weight loss can be highly variable beyond 1-year postsurgery. This study examines and compares the frequency distribution of weight loss and lack of treatment effect rates after laparoscopic Roux-en-Y gastric bypass, laparoscopic sleeve gastrectomy, and laparoscopic adjustable gastric banding.

Methods: A total of 1,331 consecutive patients at a single academic institution were reviewed from a prospectively collected database. Preoperative data collected included demographics, body mass index, and percent excess weight loss. Postoperative BMI and %EWL were collected at 12, 24, and 36 months. Percent excess weight loss was analyzed by the percentiles of excess weight lost, and the distribution of percent excess weight loss was evaluated in 10% increments. Lack of a successful treatment effect was defined as <25% excess weight loss.

Results: Of the 1,331 patients, 72.4% (963) underwent laparoscopic Roux-en-Y gastric bypass, 18.3% (243) laparoscopic sleeve gastrectomy, and 9.4% (125) laparoscopic adjustable gastric banding. Mean percent excess weight loss was greatest for laparoscopic Roux-en-Y gastric bypass, followed by laparoscopic sleeve gastrectomy, and then by laparoscopic adjustable gastric banding at every time point: at 2 years mean percent excess weight loss was 77.9 ± 24.4 for laparoscopic Roux-en-Y gastric bypass, 50.8 ± 25.8 for laparoscopic sleeve gastrectomy, and 40.8 ± 25.9 for laparoscopic adjustable gastric banding ($P < .0001$). The rates of a successful treatment effect s for laparoscopic Roux-en-Y gastric bypass, laparoscopic sleeve gastrectomy, and laparoscopic adjustable gastric banding were 0.9%, 5.2%, and 24.3% at 1 year; 0.3%, 11.1%, and 26.0% at 2 years; and 1.0%, 25.3%, and 30.2% at 3 years. At 1 year, the odds ratio of lack of a successful treatment effect of laparoscopic sleeve gastrectomy versus laparoscopic Roux-en-Y gastric bypass was 6.305 (2.125–19.08; $P = .0004$), the odds ratio for laparoscopic adjustable gastric banding versus laparoscopic Roux-en-Y gastric bypass was 36.552 (15.64–95.71; $P < .0001$), and the odds ratio for laparoscopic adjustable gastric banding versus laparoscopic sleeve gastrectomy was 5.791 (2.519–14.599; $P < .0001$). At 2 years, the odds ratio for laparoscopic sleeve gastrectomy versus laparoscopic Roux-en-Y gastric bypass increased to 70.7 (9.4–531.7; $P < .0001$), the odds ratio for laparoscopic adjustable gastric banding versus laparoscopic Roux-en-Y gastric bypass increased to 128.1 (16.8–974.3; $P < .0001$), and the odds ratio for laparoscopic adjustable gastric banding versus laparoscopic sleeve gastrectomy decreased to 1.8 (0.9–3.6; $P = .09$).

Conclusion: This study emphasizes the existing variability in weight loss across bariatric procedures as well as in the lack of a treatment effect for each procedure. Although laparoscopic adjustable gastric banding has the greatest rate of a lack of a successful treatment effect, the rate remained stable over 3 years postoperatively. Laparoscopic sleeve gastrectomy showed a doubling in the rate of a lack of a successful treatment effect every year reaching 25% at year 3. The rates for lack of a successful

* Reprint requests: John Morton, MD, MPH, FACS, FASMBS, Stanford School of Medicine, Bariatric and Minimally Invasive Surgery, 300 Pasteur Drive, H3680, Stanford, California 94305.

E-mail address: morton@stanford.edu (J. Morton).

treatment effect for laparoscopic Roux-en-Y gastric bypass remained stable at about 1% for the first 3 years postoperatively.

© 2018 Elsevier Inc. All rights reserved.

Introduction

Bariatric surgery has been shown to be an effective and enduring long-term treatment for morbid obesity.¹ Laparoscopic Roux-en-Y gastric bypass (LRYGB) has remained at the forefront of bariatric procedures for the past 2 decades, with excellent results.² The laparoscopic adjustable gastric banding (LAGB) has seen more variation in overall results.³ Lately, the laparoscopic sleeve gastrectomy (LSG) has become widely adopted, recently surpassing LRYGB as the most commonly performed bariatric procedure in the United States according to the American Society for Metabolic and Bariatric Surgery.⁴ The current literature reports outcomes after bariatric surgery using metrics such as percent excess body weight loss, percent excess body mass index loss, total absolute weight loss, and percent excess weight loss (%EWL). Although each of these metrics of weight loss has its advantages and limitations, all are typically reported using the mean \pm standard deviation. Although reporting means and standard deviations as measures of central tendency provides an adequate tool for overall comparisons, these statistics often only partially describe their corresponding distributions. Reports of weight loss as mean \pm standard deviation of continuous variables (whether percent or actual weight loss) assume a normal distribution of the data, but if the data are not normally distributed, different statistical tools are needed to analyze the reported data. Therefore, it is of importance to know the variability that exists regarding weight loss after each weight loss procedure and to evaluate if these data follow a normal distribution.

In clinical practice, variation in weight loss between patients undergoing the same bariatric procedure is commonly observed. Such variation is often poorly reflected by procedure-estimated standard deviations alone. Indeed, 1 of the most challenging aspects of LAGB is the wide variation in weight loss that occurs in this population. Bessler et al. demonstrated this variation in a study on frequency distribution of weight loss after LRYGB and LAGB. This study confirmed that the distribution was different between the 2 procedures with initial weight loss being less predictable after LAGB and the 2–3 year weight loss no longer following a normal, single-peak distribution.⁵ The breadth of variation between individuals undergoing the same procedure is potentially important information, with potential clinical implications including in individual selection of the appropriate procedure and patient counseling. This variation in results after LAGB for example has led to multiple studies trying to identify predictors of success after LAGB.^{6–8}

The comparative rates of lack of a successful treatment effect of each procedure is also an important metric and is seldom reported outside of revisional procedure publications.⁹ Multiple definitions have been published, but no clear consensus exists regarding the definition of lack of a successful treatment effect in bariatric surgery.^{10,11} Furthermore, although some comparative effectiveness studies exist comparing the major procedures, few studies have focused directly and specifically on the rates of a lack of a successful treatment effect of the operations.^{12–14} This metric could, however, prove to be a useful tool for patient counseling.

The variability of weight loss and rates of a lack of a successful treatment effect after bariatric surgery have not, to the best of our knowledge, been measured nor compared between the 3 current,

most frequently performed bariatric procedures. The aim of this study was to evaluate the heterogeneity of weight loss between LRYGB, LSG, and LAGB as well as compare their relative rates of a lack of a successful treatment effect over the first 3 years postoperatively.

Methods

All patient data were collected prospectively and entered in our institutional IRB-approved database (2004–2014). Prospective data were collected for 1,331 consecutive patients and analyzed retrospectively. Preoperative data collected included patients' demographic information, BMI, and excess body weight. Excess body weight was calculated based on a goal BMI of 25 kg/m² using their ideal body weight per the Metropolitan-Life Ideal Body Weight Tables. Weight loss after bariatric surgery was tracked as change in BMI and as the %EWL. Postoperative BMI and %EWL were collected at 3, 6, 12, 24, and 36 months. Total %EWL was analyzed by the percentiles of excess weight lost, and the distribution of %EWL was evaluated in 10% increments. Treatment effect was classified based on the Reinhold criteria.¹¹ High weight loss effect was defined as >50% EWL, moderate weight loss effect was defined as 50%>EWL>25%, and lack of a successful treatment effect as <25% EWL.

All operations were performed in a standardized, laparoscopic fashion. LRYGB was performed with a standard LRYGB 30 cm³ pouch and a 125-cm Roux limb. LSG was performed over an upper endoscope sizing the sleeve to approximately 36F. LAGB was performed using Allergan, Irvine, CA Realize, Cincinnati, Ohio.

Descriptive statistics including mean, median, standard deviation, skew, and kurtosis were calculated for each procedure at all time points. Mean weight for the 3 procedures at various time points were compared using the Kruskal-Wallis test. The Shapiro-Wilk normality test was used to determine whether %EWL distributions followed a normal distribution. Conditional maximum likelihoods were used to produce estimates of odds ratios (ORs) and 95% confidence intervals (CI), Fisher's exact test to produce *P* values for differences in the rates of high treatment effect on weight loss and lack of a successful treatment effect and the Brown-Forsythe method to test for differences in variance in %EWL.¹⁵ Missing values were ignored. All statistical analysis was performed using SAS Studio 4.3.

Results

Patient demographics are detailed in Table 1. LAGB patients were on average older and more often Caucasian, whereas LRYGB patients had the greatest preoperative BMI and longest length of stay.

Weight loss results are illustrated in Fig 1 and detailed in Table 2. As expected, mean %EWL was greatest for LRYGB, followed by LSG, followed by LAGB at every time point.

At 3 and 6 months, LRYGB and LSG weight loss followed a similar non-normal distribution whereas LAGB followed a different distribution. At 12 months, weight loss results followed a normal distribution after all three procedures (Table 2). However, at 24 and 36 months, %EWL followed a normal distribution only after LRYGB but no longer for LSG or AGB. As shown in Fig 1, both LAGB and LSG appear to follow a flatter distribution of %EWL at 24 and 36 months. Indeed, at 24-months postop for LSG and at

Table 1
Preoperative demographic data by procedure

	LRYGB (n = 963)	LSG (n = 243)	LAGB (n = 125)	P value
Age, y (mean ± SD)	45.31 ± 10.64	45.97 ± 11.20	47.74 ± 12.20	.0572
Weight, lb (mean ± SD)	287.3 ± 54.45	268.8 ± 46.81	268.7 ± 46.48	<.0001
BMI* (mean ± SD)	46.92 ± 7.45	43.87 ± 6.13	43.35 ± 5.24	<.0001
Female (%)	81.5%	77.8%	75.2%	.1408
Caucasian race (%)	59.4%	51.9%	65.6%	.0179
Private insurance (%)	78.9%	78.6%	82.4%	.0402

* BMI calculated as kg/m²

Table 2
Characteristics of %EWL over time

Procedure	Mean ± SD	Median (25th, 75th percentile)	Range (min, max)	Shapiro-Wilk P value	Kurtosis
12 months					
RYGB (n = 916)	74.52 ± 21.98	72.29 (60.21, 88.35)	(−1.13, 164.2)	<.0001	.564
LSG (n = 219)	57.04 ± 22.76	57.37 (39.75, 70.67)	(9.29, 124.3)	.0097	.065
LAGB (n = 111)	40.60 ± 24.66	41.60 (24.97, 52.69)	(−27.09, 133.2)	.0045	2.201
24 months					
RYGB (n = 334)	77.87 ± 24.36	77.20 (60.75, 92.87)	(−9.95, 192.0)	<.0001	2.516
LSG (n = 120)	50.76 ± 25.85	49.63 (32.69, 66.80)	(−3.66, 112.3)	.1298	−.525
LAGB (n = 72)	40.85 ± 25.92	38.68 (23.77, 53.97)	(−17.52, 103.9)	.0687	.057
36 MONTHS					
RYGB (n = 193)	75.58 ± 22.63	77.75 (60.74, 89.12)	(23.93, 171.6)	.0192	.974
LSG (n = 75)	43.69 ± 26.43	40.15 (22.84, 64.27)	(−20.01, 113.7)	.4948	−.109
LAGB (n = 43)	40.01 ± 24.01	37.21 (22.68, 60.02)	(−0.31, 96.37)	.5423	−.520

Table 3
Postoperative treatment effect rates based on %EWL cutoffs

12 months	LRYGB (n = 916)	LSG (n = 219)	LAGB (n = 111)
Lack of a successful treatment effect (%EWL < 25%)	0.9%	6.4%	25.2%
Intermediate treatment effect (25% < %EWL < 50%)	10.7%	32.6%	45.1%
High treatment effect (%EWL ≥ 50%)	88.4%	61.0%	29.7%
24 months			
	LRYGB (n = 334)	LSG (n = 120)	LAGB (n = 72)
Lack of a successful treatment effect (%EWL < 25%)	0.3%	17.7%	27.8%
Intermediate treatment effect (25% < %EWL < 50%)	10.8%	34.5%	43.1%
High treatment effect (%EWL ≥ 50%)	88.9%	47.9%	29.2%
36 months			
	LRYGB (n = 193)	LSG (n = 75)	LAGB (n = 43)
Lack of a successful treatment effect (%EWL < 25%)	1.0%	25.3%	30.2%
Intermediate treatment effect (25% < %EWL < 50%)	12.4%	36.0%	37.2%
High treatment effect (%EWL ≥ 50%)	86.5%	38.7%	32.6%

Table 4
Odds of high treatment versus lack of a successful treatment effect: weight loss 12 months after bariatric surgery

Reference	Comparison	High effect on weight loss (%EWL ≥ 50%)			Lack of a successful effect on weight loss			Brown-Forsythe P value
		OR	95% CI	P value	OR	95% CI	P value	
LRYGB	LSG	0.21	0.15–0.29	<.0001	7.8	3.2–18.7	<.0001	.44
LRYGB	LAGB	0.06	0.04–0.09	<.0001	38.2	16.9–86.7	<.0001	.37
LSG	LAGB	0.27	0.17–0.45	<.0001	4.9	2.5–9.9	<.0001	.79

Table 5
Odds of high treatment versus lack of a successful treatment effect: weight loss 24 months after bariatric surgery

Reference	Comparison	High effect on weight loss (%EWL ≥ 50%)			Lack of a successful effect on weight loss (%EWL < 25%)			Brown-Forsythe P value
		OR	95% CI	P value	OR	95% CI	P value	
LRYGB	LSG	0.11	0.1–0.2	<.0001	70.7	9.4–531.7	<.0001	.19
LRYGB	LAGB	0.05	0.0–0.1	<.0001	128.1	16.8–974.3	<.0001	.66
LSG	LAGB	0.46	0.2–0.9	.01	1.8	0.9–3.6	.09	.60

36-months postop for both LAGB and LSG had negative Kurtosis values (−0.525, −0.109, and −0.520 respectively), whereas LRYGB continued to have a positive Kurtosis value (Kurtosis = .974). The effects of treatment on weight loss are detailed in Table 3. Odds of high treatment versus lack of a successful treatment effect are reported in Tables 3–6. At 1 year, lack of successful treatment

effect rates were different between each pair of procedures (all P's < .0001). At this time point of 1 year postop, the OR of lack of a successful treatment effect of the LSG compared to LRYGB was 6.305 (2.125–19.08; P = .0004). When LAGB was compared to LRYGB, the OR was 36.552 (15.64–95.71; P < .0001) and comparing LAGB to LSG, the OR was 5.791 (2.519–14.599; P < .0001).

Percent Excess Weight Loss (%EWL) Frequency Distributions and Gaussian Curves

■ RYGB ■ LSG ■ LAGB

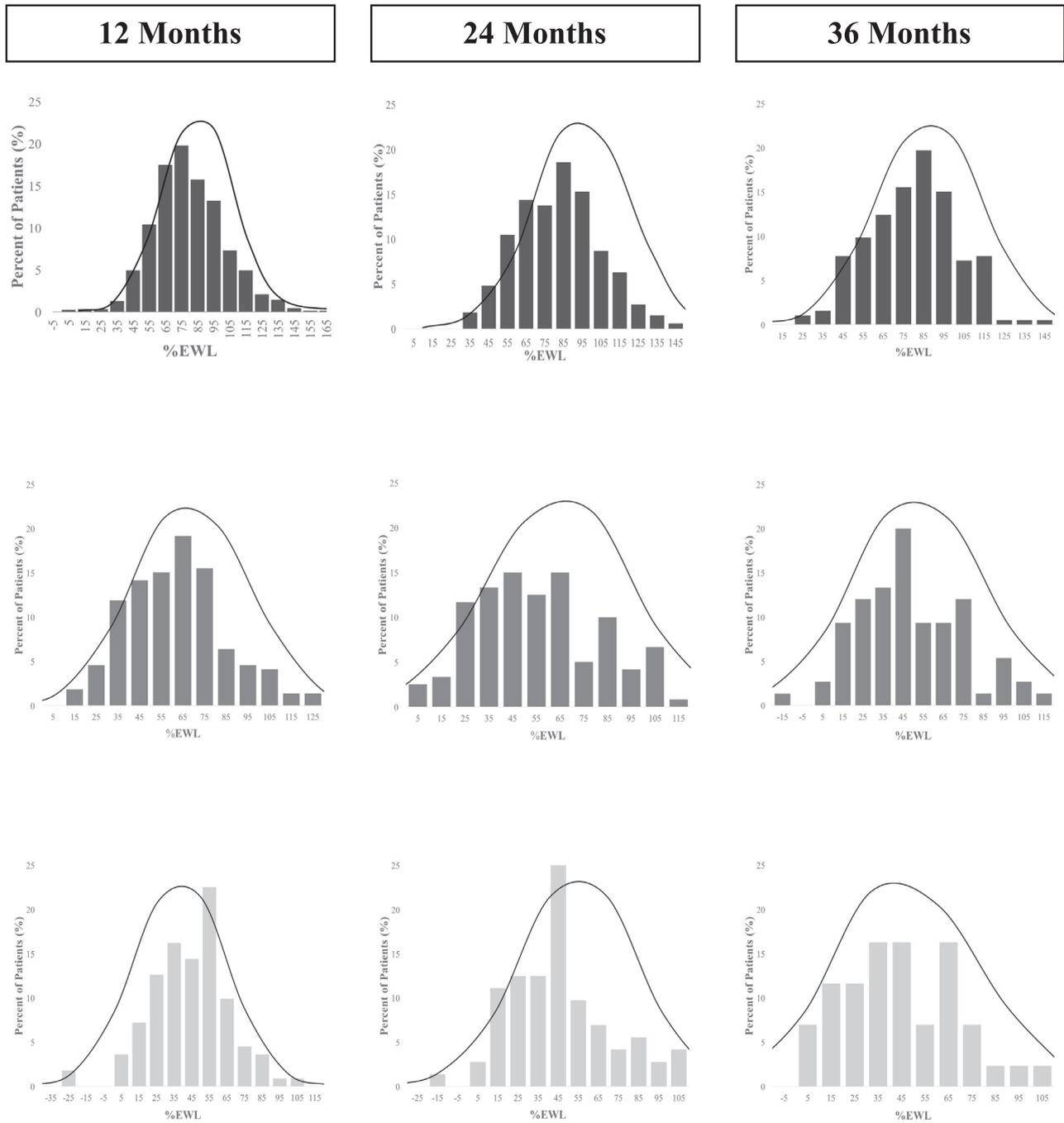


Fig. 1. Frequency distribution of %EWL in 10% increments for LRYGB, LSG, and LAGB patients.

Table 6

Odds of high treatment versus lack of a successful treatment effect: weight loss 36 months after bariatric surgery

Reference	Comparison	High effect on weight loss (%EWL ≥ 50%)			Lack of a successful effect on weight loss (%EWL < 25%)			Brown-Forsythe P value
		OR	95% CI	P value	OR	95% CI	P value	
RYGB	LSG	0.10	0.05–0.18	<.0001	32.4	7.3–143.4	<.0001	.12
RYGB	LAGB	0.08	0.04–0.16	<.0001	41.4	8.9–192.6	<.0001	.55
LSG	LAGB	0.77	0.35–1.7	.51	1.3	0.6–2.9	.57	.57

Table 7
Baseline participant characteristics by missing follow-up data

Baseline traits	12-month data Follow-up rate: 93.6%			24-month data Follow-up rate: 39.5%			36-month data Follow-up rate: 23.4%		
	Not missing	Missing	P value	Not missing	Missing	P value	Not missing	Missing	P value
Age, y (mean ± SD)	45.8 ± 10.9	43.5±10.9	.0625	46.0 ±10.9	45.4 ±10.9	.3156	46.2 ±10.8	45.5 ±10.9	.3163
Weight, lb (mean ± SD)	282.6 ±53.4	274.9 ±48.0	.1918	281.2 ±55.4	282.8 ±51.5	.5962	278.2 ±52.0	283.4 ±53.3	.1311
BMI* (mean ± SD)	46.1 ±7.2	44.7 ±6.3	.0819	45.9 ±7.4	46.1 ±7.1	.4992	45.8 ±6.9	46.1 ±7.3	.4718
Female (%)	80.3	80.0	.9541	79.3	80.9	.4758	81.0	80.0	.6899
Caucasian race (%)	59.1	51.8	.5261	54.6	61.2	.0033	54.0	60.0	.2188
Private insurance (%)	79.0	81.2	.1241	78.1	79.8	.5186	76.8	79.9	.4281

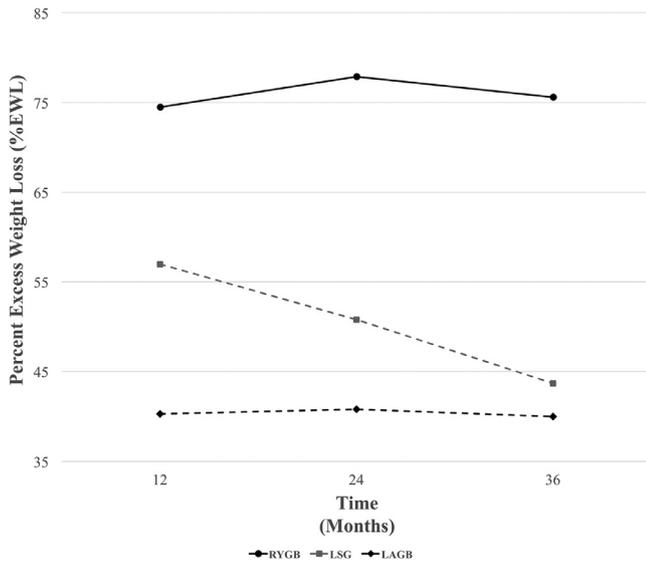


Fig. 2. Average %EWL over time.

At 2 years postop, the OR of lack of a successful treatment effect for LSG compared to LRYGB increased to 70.7 (9.4–531.7; $P < .0001$), when LAGB was compared to LRYGB the OR became 128.1 [16.8–974.3]; ($P < .0001$), and comparing LAGB to LSG the OR decreased to 1.8 (0.9–3.6; $P = .09$).

At 3 years postop, the OR of lack of a successful treatment effect for LSG compared with LRYGB was to 32.4 (7.3–143.4; $P < .0001$), when LAGB was compared to LRYGB the OR was 41.4 (8.9–192.6; $P < .0001$) and comparing LAGB to LSG the OR decreased to 1.3 (0.6–2.9; $P = .57$).

Discussion

This study highlights the variability regarding weight loss outcomes after the 3 most common current bariatric procedures. Heterogeneity of weight loss (Fig. 2) was comparable between the different procedures for the first postoperative year, but at the 2- and 3-year time points, weight loss after LSG and LAGB no longer followed a normal distribution, whereas after LRYGB, the weight loss remained normally distributed.

Similar to what has been reported previously regarding weight loss or complication rates,^{12–14} heterogeneity and lack of treatment effect rates of weight loss after LSG appear to be between those of LRYGB and LAGB. The progressive increase in lack of a successful treatment effect as well as the change in distribution over time raises the question of patient selection and other factors that influence weight loss after LSG. Further studies should be performed to better determine these factors and improve selection of the best procedure for patients. More importantly, the rates of a lack of a successful treatment effect were very markedly different after all 3 procedures. LRYGB provided the lowest rate of a lack of a

successful treatment effect (when measured as %EWL of all 3 procedures with a steady and very low rate of a lack of a successful treatment effect of under 1% at 1 or 2 years postop). Patients undergoing LSG had a 7.8-fold increased risk of a lack of successful treatment effect at 1 year and a 7.1-fold increased risk at 2 years compared to LRYGB. Although the LAGB was even less successful than the LSG, the rates of a lack of a successful treatment effect after LAGB were nearly constant over the first 2 postoperative years.

Each year, the lack of a successful treatment effect doubled in the LSG group. This finding is noteworthy because LSG has become more common and further long-term studies are required to determine if and when a plateau is achieved. It is important to determine if the rates of recidivism are going to become a potentially detrimental issue for patients undergoing LSG. This increasing rate of a lack of a successful treatment effect may foreshadow the need for LSG patients to require further intervention or surgical conversion in the coming years. Furthermore, this worrisome rate of a lack of a successful treatment effect at 1 and 2 and 3 years increases the need to identify at-risk patients, ideally preoperatively, to guide them preferentially toward LRYGB as a preferred procedure choice.

Indeed, our results demonstrate that LRYGB remains the most efficient bariatric procedure analyzed here, with the lowest lack of a successful treatment effect and the most predictable outcomes in terms of expected weight loss.

It should be noted that although weight loss in an important outcome of bariatric procedures, resolution of comorbidities, and especially diabetes, likely carries the greatest clinical benefit for our patients. Weight loss outcomes should not be the only factor to impact decision-making. Furthermore, clinically relevant improvements in comorbidities will occur even with lesser amounts of weight loss. Our paper, however, provides novel information that could improve the counseling of our patients in terms of weight-related recidivism risks after bariatric procedures. Certain limitations of this study need to be mentioned, mostly inherent to its retrospective analysis design. First, procedure selection was not randomized, and the criteria of our group for selecting LSG versus LRYGB are reflected in the demographic table. Patients with diabetes or a greater BMI are more likely to undergo LRYGB. Similarly, LSG could not be performed on Medicare patients for a portion of time, making LAGB a more frequent procedure in this population. Second, loss to follow-up remains a substantial issue, especially after the first postoperative year. Although our team deploys considerable and repeated efforts to contact patients for follow-up, the follow-up rate in most all bariatric practices remains an unsolved problem and requires continuing improvement. We did compare preoperative characteristics between patients with and without follow-up (Table 7), but no significant differences were found except for race at 2 years.

In conclusion, this study emphasizes the existing variability in weight loss across the 3 currently popular bariatric procedures as well as in the lack of a successful treatment effect as defined by <25% EWL. Although LAGB has the greatest rate of a lack of a successful treatment effect, the rate tended to remain stable over the

first 3 postoperative years. LSG showed a doubling in the rate of a lack of a successful treatment effect every year, reaching fully 25% at year 3, whereas rates for LRYGB stayed stable at about 1%. The variability and increases in the rate of a lack of a successful treatment effect seen after LSG should mandate further research into the factors influencing weight loss after LSG.

Conflicts of interest

References

- Colquitt JL, Pickett K, Loveman E, Frampton GK. Surgery for weight loss in adults. *Cochrane Database Syst Rev*. 2014;8.
- Mason EE, Ito C. Gastric bypass. *Ann Surg*. 1969;170:329–339.
- Himpens J, Cadiere GB, Bazi M, Vouche M, Cadiere B, Dapri G. Long-term outcomes of laparoscopic adjustable gastric banding. *Arch Surg*. 2011;146:802–807.
- ASMBS estimates of bariatric procedures [Internet]. [cited 2015 Jun 4]. Available from: <https://asmbs.org/resources/estimate-of-bariatric-surgery-numbers>
- Bessler M, Daud A, DiGiorgi MF, Schrope BA, Inabnet WB, Davis DG. Frequency distribution of weight loss percentage after gastric bypass and adjustable gastric banding. *Surgery for Obesity and Related Diseases*. 2008;4:486–491.
- Bueter M, Thalheimer A, Lager C, Schowalter M, Illert B, Fein M. Who benefits from gastric banding? *Obes Surg*. 2007;17:1608–1613.
- Chevallier J-M, Paita M, Rodde-Dunet M-H, Marty M, Nogues F, Slim K, et al. Predictive factors of outcome after gastric banding. *Ann Surg*. 2007;246:1034–1039.
- Thalheimer A, Bueter M, Wierlemann A, Lager C, Jurowich C, Germer C-T, et al. Predictability of outcome in laparoscopic gastric banding. *Obes Facts*. 2009;2(Suppl 1):27–30.
- Mann JP, Jakes AD, Hayden JD, Barth JH. Systematic review of definitions of failure in revisional bariatric surgery. *Obes Surg*. 2014;25:571–574.
- Biron S, Hould F-S, Lebel S, Marceau S, Lescelleur O, Simard S, et al. Twenty years of biliopancreatic diversion: what is the goal of the surgery? *Obes Surg*. 2004;14:160–164.
- Reinhold RB. Critical analysis of long term weight loss following gastric bypass. *Surg Gynecol Obstet*. 1982;155:385–394.
- Carlin AM, Zeni TM, English WJ, Hawasli AA, Genaw JA, Krause KR, et al. The comparative effectiveness of sleeve gastrectomy, gastric bypass, and adjustable gastric banding procedures for the treatment of morbid obesity. *Ann Surg*. 2013;257:791–797.
- Dogan K, Gadiot RPM, Aarts EO, Betzel B, van Laarhoven CJHM, Biter LU, et al. Effectiveness and safety of sleeve gastrectomy, gastric bypass, and adjustable gastric banding in morbidly obese patients: a multicenter, retrospective, matched cohort study. *Obes Surg*. 2015;25:1110–1118.
- Hutter MM, Schirmer BD, Jones DB, Ko CY, Cohen ME, Merkow RP, et al. First report from the American College of Surgeons Bariatric Surgery Center Network. *Ann Surg*. 2011;254:410–422.
- Brown MB, Forsythe AB. Robust tests for the equality of variances. *Journal of the American Statistical Association*. 1976;69:364–367.