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Laparoscopic Sleeve Gastrectomy or Laparoscopic Gastric Bypass for Patients with Metabolic Syndrome: An MBSAQIP Analysis

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In patients undergoing bariatric surgery, the presence of metabolic syndrome (MetS) contributes to perioperative morbidity. We aimed to evaluate the utilization and outcome of severely obese patients with MetS who underwent laparoscopic sleeve gastrectomy (LSG) *versus* laparoscopic Roux-en-Y gastric bypass (LRYGB). Using the 2015 and 2016 Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program database, data were obtained for patients with MetS undergoing LSG or LRYGB. There were 29,588 MetS patients (LSG: 58.7% *vs* LRYGB: 41.3%). There was no significant difference in 30-day mortality (0.1% for LSG *vs* 0.2% for LRYGB, adjusted odds ratio (AOR) 0.58, confidence interval (CI) 0.32–1.05, *P* 5 0.07) or length of stay between groups (2 6 2 for LSG *vs* 2.2 6 2 days for LRYGB, *P* 5 0.40). Compared with LRYGB, LSG was associated with significantly shorter operative time (78 6 39 *vs* 122 6 54 minutes, *P* <0.01), lower overall morbidity (2.3% *vs* 4.4%, AOR 0.53, CI 0.46–0.60, *P* <0.01), lower serious morbidity (1.5% *vs* 2.3%, AOR 0.64, CI 0.53–0.76, *P* <0.01), lower 30-day reoperation (1.2% *vs* 2.3%, AOR 0.52, CI 0.43–0.63, *P* <0.01), and lower 30-day readmission (4.2% *vs* 6.6%, AOR 0.62, CI 0.55–0.69, *P* <0.01). In conclusion, LSG is the predominant operation being performed for severely obese patients with MetS, and its popularity may in part be related to its improved perioperative safety profile.

According to the World Health Organization, more than 1.9 billion adults were overweight in 2016 and over 600 million were obese.[1] In the United States, 68 per cent of adults are overweight or obese.[2] Obesity is the main cause of metabolic syndrome (MetS), which represents a cluster of metabolic abnormalities largely resulting from the presence of abdominal obesity which is closely linked to insulin resistance and cardiovascular disease. It has been reported that the prevalence of MetS reached approximately 35 to 40 per cent of the United States adult population.[3] Despite differences in its definition, MetS includes a combination of insulin resistance or type II diabetes, hyperglycemia, hypertension, atherogenic dyslipidemia, and abdominal obesity.[4] The syndrome is associated with an increased risk for diseases, including coronary heart disease, nonalcoholic fatty liver disease, stroke, obstructive sleep apnea, and gastroesophageal reflux.

Compared with lifestyle (diet and exercise) and pharmacological interventions, bariatric surgery has been proven to be the most effective long-term treatment for obesity and its comorbidities.[5, 6] Laparoscopic sleeve gastrectomy (LSG) and laparoscopic Roux-en-Y gastric bypass (LRYGB) are presently the most commonly performed bariatric operations in the United States.[7, 8] LSG became increasingly popular over the past decade because of its safety profile and long-term efficacy and is now the most common bariatric operation being performed in the

United States.[9] Although LSG is presently the most common bariatric procedure in the United States, there is evidence to suggest that LRYGB is more effective than LSG for remission of type 2 diabetes. Meta-analysis of five randomized clinical trials (RCTs) demonstrated that LRYGB is more effective than LSG for surgical treatment of type II diabetes and control of MetS.[10, 11] The aim of this study was to analyze the contemporary utilization and outcomes of severely obese patients with MetS who underwent LSG versus LRYGB.

Methods

Data Source

We performed a retrospective cohort study using the 2015 and 2016 Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP) database. The MBSAQIP database was created in 2012 by the ACS and the American Society for Metabolic and Bariatric Surgery. The MBSAQIP is a rigorous dataset that captures 100 per cent of all bariatric cases at each participating institution and has clear definitions of data parameters and data collected by a certified clinical reviewer.

Study Design and Population

Following the 1999 WHO clinical criteria for MetS, clinical data were reviewed on obese patients (BMI $\geq$ 35) with a preoperative history of hypertension, diabetes mellitus, or hyperlipidemia who underwent LSG (Current Procedural Terminology code 43775) and LRYGB (Current Procedural Terminology code of 43644 and 43645) for the treatment of severe obesity. Emergent, revisional, and converted cases were excluded. Preoperative characteristics, comorbidities, and 30-day outcomes were analyzed according to LSG *versus* LRYGB. Serious morbidity was defined to include anastomotic leak, organ space SSI, wound dehiscence, ventilator dependence more than 48 hours, progressive renal insufficiency, acute renal insufficiency, cerebrovascular accidents/stroke, cardiac arrest, myocardial infarction, bleeding requiring transfusion, pulmonary embolism, sepsis, and septic shock. The MBSAQIP does not have a specific variable for leak; therefore, postoperative leak is defined as a composite of surgical drain present >30 days, organ space SSI, leak-related 30-day readmission, leak-related 30-day reoperation, or leak-related 30-day intervention.

Statistical Analysis

Statistical analyses were performed using SPSS software, version 23 (SPSS Inc., Chicago, IL). Categorical data were reported as percentages and compared between groups using chi-squared tests. Continuous data were reported as mean ± SD and compared between groups using student t-tests. A multivariate logistic regression model was used to compare 30-day outcome for LSG *versus* LRYGB. Variables included within the multivariate analyses included demographic data (age, gender, race, and BMI) and preoperative comorbidities. For each outcome variable, the adjusted odds ratio (AOR) with a 95 per cent confidence interval (CI) was calculated. Statistical significance was set at $P < 0.05$.

Results

Of the 296,206 severely obese patients undergoing bariatric surgery during the study period, 29,588 (10%) patients had MetS and underwent LSG 17,368 (58.7%) or 12,220 (41.3%) LRYGB. Table 1 summarizes the characteristics and comorbidities of patients who underwent LSG *versus* LRYGB. With respect to demographics, there were no significant differences between groups regarding age, ethnicity, or BMI. With regard to preoperative comorbidity, sleep apnea (59.6% vs 55.3%, P < 0.01) and gastroesophageal reflux disease (44.8% vs 39.5%, P < 0.01) were significantly higher in the LRYGB group, whereas COPD (4.8% vs 4.2%, P < 0.01), use of dialysis (1% vs 0.4%, P < 0.01), renal insufficiency (2.6% vs 1.8%, P < 0.01), and chronic steroid use (2.6% vs 1.8%, P < 0.01) were significantly higher in the LSG group.

Compared with the LSG group, patients who underwent LRYGB had longer mean operative time (122 ± 54 vs 78 ± 39 minutes, P < 0.01), but the mean length of hospital stay was similar between the two groups (2 ± 2 for LSG vs 2 ± 2 days for LRYGB, respectively, P 4 0.40).

Table 2 summarizes the multivariate logistic regression model comparing the outcome of LSG versus LRYGB. There was no significant difference in 30-day mortality between LSG versus LRYGB (0.1% vs 0.2%, respectively, AOR 0.58; 95% CI 0.32–1.05; P 4 0.07). Compared with LRYGB, LSG was associated with significantly lower overall morbidity (2.3% vs 4.4%, AOR 0.53, 95% CI 0.46–0.60, P < 0.01) and severe morbidity (1.5% vs 2.3%, AOR 0.64, 95% CI 0.53–0.76, P < 0.01). Compared with LRYGB, risk-adjusted rates of the following morbidities were significantly lower in the LSG group: acute renal failure (LSG 0.2% vs LRYGB 0.3%, AOR 0.58, 95% CI 0.35–0.94, P = 0.02); renal insufficiency (LSG 0.1% vs LRYGB 0.3%, AOR 0.54, 95% CI 0.32–0.91, P = 0.02); ventilator dependency (LSG 0.1% vs LRYGB 0.2%, AOR 0.38, 95% CI 0.18–0.79, P = 0.01); pneumonia (LSG 0.3% vs LRYGB 0.6%, AOR 0.38, 95% CI 0.26–0.56, P < 0.01); superficial SSI (LSG 0.4% vs LRYGB 1.6%, AOR 0.25, 95% CI 0.19–0.33, P < 0.01), deep SSI (LSG 0% vs LRYGB 0.2%, AOR 0.14, 95% CI 0.05–0.43, P < 0.01), and any SSI (LSG 0.7% vs LRYGB 2.1%, AOR 0.33, 95% CI 0.26–0.41, P < 0.01); septic shock (LSG 0% vs LRYGB 0.1%, AOR 0.36, 95% CI 0.14–0.91, P 4 0.03); rates of transfusion (LSG 1% vs LRYGB 1.5%, AOR 0.64, 95% CI 0.52–0.80, P < 0.01); 30-day reoperation (LSG 1.2% vs LRYGB 2.3%, AOR 0.52, 95% CI 0.43–0.63, P < 0.01); and 30-day readmission (LSG 4.2% vs LRYGB 6.6%, AOR 0.62, 95% CI 0.55–0.69, P < 0.01).

TABLE 1. *Characteristics and Comorbidities of Patients with MetS Who Underwent LSG versus LRYGB*

Patient Characteristics, Comorbidities, and Perioperative Outcome		LSG (n 4 17,368)	LRYGB (n 4 12,220)	*P*-Value
Age	Mean age, year ± SD	54 ± 10	53 ± 10	0.07
Gender	Female	11,114 (64%)	7,999 (65.5%)	Ref.
BMI	Mean BMI, kg/m² ± SD	45.6 ± 8	45.7 ± 8	0.06
Race, n (%)	White,	13,123 (75.6%)	9,490 (77.7%)	Ref.
	Black	2,949 (17%)	1,733 (14.2%)	0.31
	Asian	118 (0.7%)	78 (0.6%)	0.06
	Other	85 (0.5%)	126 (1%)	0.10
	Missing	1,093 (6.3%)	793 (6.5%)	
ASA	ASA class, 2 or greater	15,667 (90.2%)	11,342 (92.8%)	<0.01
Comorbidities, n (%)	Smoke	1,417 (8.2%)	927 (7.6%)	0.07
	Gastroesophageal reflux disease	6,864 (39.5%)	927 (44.8%)	<0.01
	COPD	829 (4.8%)	513 (4.2%)	<0.01
	Dialysis	176 (1%)	48 (0.4%)	<0.01
	Chronic steroid use	446 (2.6%)	221 (1.8%)	<0.01
	Renal insufficiency	479 (2.8%)	280 (2.3%)	<0.01
	History of deep vein thrombosis	485 (2.8%)	349 (2.9%)	0.74
	History of pulmonary embolism	321 (1.8%)	204 (1.7%)	0.25
	Venous stasis	432 (2.5%)	348 (2.8%)	0.06
	Obstructive sleep apnea	9,599 (55.3%)	7,282 (59.6%)	<0.01
	Oxygen dependent	393 (2.3%)	270 (2.2%)	0.76
	Mean length of hospital stay, days ± SD	2 ± 2	2.2 ± 2	0.40
	Mean operative time, minutes ± SD	78 ± 39	122 ± 54	<0.01

ASA, American Society of Anesthesiology.

TABLE 2. *Risk-Adjusted Outcomes of Patients with MetS Who Underwent LSG versus LRYGB*

30-Days of Morbidity & Mortality	LSG (n 4 17,368)	LRYGB (Reference) (n 4 12,220)	AOR	CI	*P*-Value
30-day mortality, n (%)	25 (0.1%)	24 (0.2%)	0.58	0.32–1.05	0.07
30-day reoperation, n (%)	213 (1.2%)	282 (2.3%)	0.52	0.43–0.63	<0.01
30-day readmission, n (%)	723 (4.2%)	807 (6.6%)	0.62	0.55–0.69	<0.01
30-day overall morbidity, n (%)	405 (2.3%)	533 (4.4%)	0.53	0.46–0.60	<0.01
30-day serious morbidity, n (%)	254 (1.5%)	279 (2.3%)	0.64	0.53–0.76	<0.01
Anastomotic leak, n (%)	100 (0.6%)	94 (0.8%)	0.75	0.56–1.01	0.06
Acute renal failure, n (%)	31 (0.2%)	37 (0.3%)	0.58	0.35–0.94	0.02
Renal insufficiency, n (%)	25 (0.1%)	36 (0.3%)	0.54	0.32–0.91	0.02
Urinary tract infection, n (%)	90 (0.5%)	79 (0.6%)	0.81	0.59–1.11	0.21
Unplanned intubation, n (%)	48 (0.3%)	43 (0.4%)	0.74	0.48–1.13	0.16
Ventilator dependency, n (%)	11 (0.1%)	21 (0.2%)	0.38	0.18–0.79	0.01
Pneumonia, n (%)	44 (0.3%)	79 (0.6%)	0.38	0.26–0.56	<0.01
Any respiratory complication, n (%)	88 (0.5%)	124 (1%)	0.48	0.36–0.63	<0.01
Pulmonary embolism, n (%)	20 (0.1%)	18 (0.1%)	0.80	0.42–1.52	0.50
Deep vein thrombosis, n (%)	25 (0.1%)	22 (0.2%)	0.82	0.45–1.47	0.51
Venous thromboembolism, n (%)	41 (0.2%)	34 (0.3%)	0.87	0.54–1.38	0.55
Superficial SSI, n (%)	70 (0.4%)	192 (1.6%)	0.25	0.19–0.33	<0.01
Deep SSI, n (%)	5 (0.02%)	24 (0.2%)	0.14	0.05–0.43	<0.01
Organ space SSI, n (%)	44 (0.3%)	45 (0.4%)	0.75	0.48–1.51	0.18
Wound dehiscence, n (%)	8 (0.02%)	14 (0.1%)	0.39	0.15–1.01	0.05
Any SSI, n (%)	118 (0.7%)	257 (2.1%)	0.33	0.26–0.41	<0.01
Any cardiac complications, n (%)	29 (0.2%)	24 (0.2%)	0.78	0.44–1.37	0.39
Sepsis, n (%)	22 (0.1%)	22 (0.2%)	0.78	0.41–1.45	0.43
Septic shock, n (%)	7 (0.02%)	13 (0.1%)	0.36	0.14–0.91	0.03
Transfusion, n (%)	167 (1%)	182 (1.5%)	0.64	0.52–0.80	<0.01

Discussion

LRYGB had previously been recognized as the gold standard bariatric operation for the treatment of severe obesity. In recent years, utilization of LSG has increased in part because of the excellent long-term weight loss efficacy, its operative technical simplicity, and improved perioperative long-term safety outcome compared with LRYGB.[12] Within the subset of patients with type II diabetes and/or MetS, there is evidence to show that LRYGB is more effective at inducing remission of these conditions compared with LSG.[10, 11, 13, 14] In the current study examining a national cohort of severely obese patients with MetS, we found that LSG surpassed LRYGB as the procedure of choice for patients with the MetS. Compared with LRYGB, LSG was associated with a lower overall morbidity, 30-day reoperation, and 30-day readmission. The improved perioperative safety profile of the LSG may explain in part the increase in popularity of the LSG even for patients with MetS.

The most important finding from this study is that LSG is the predominant operation performed for patients with MetS, and LSG is associated with an improved perioperative safety profile. In an NSQIP study of bariatric surgery performed between 2012 and 2014, Lak and colleagues reported that patients with MetS were more likely to have Roux-en-Y gastric bypass procedures, and these patients have an increased risk for morbidity and mortality after bariatric surgery compared with patients without MetS.[15] In a study comparing the effectiveness of LSG *versus* LRYGB for obese patients with MetS, Du et al.[11] found that the remission rate of MetS was similar between the two groups (74.7% for LSG *vs* 82.5% for LRYGB); however, LSG appears to be inferior with regard to control of hypertension and improvement of high-density lipoprotein cholesterol. In a study comparing patients who underwent LSG (n = 107) *versus* LRYGB (n = 159) for remission of MetS within a VA setting, Nassour et al.[16] found that the remission rate was similar between the two groups (37.6% for LRYGB *vs* 26.8% for LSG) at four years and LRYGB was associated with a greater rate of morbidity. In a Swiss prospective randomized trial comparing LSG *versus* LRYGB, Peterli et al.[14] found that LSG and LRYGB are equally effective for weight loss and remission of comorbidities for remission of reflux and dyslipidemia which seem to be better in the LRYGB group. Overall, data demonstrating equivalent efficacy for remission of MetS and the improved safety profile of the LSG may in part drive the increase in utilization of LSG for patients with MetS. We also found that LSG was performed more frequently than LRYGB in obese patients without MetS (73.2% *vs* 26.8%). Moreover, compared with LRYGB, LSG was associated with significantly lower overall morbidity (1.2% *vs* 2.6%, $P < 0.01$) and lower serious morbidity (0.7% *vs* 1.3%, $P < 0.01$). This much lower postoperative complication rate in obese patients without MetS demonstrated that MetS had a negative impact on the surgical outcome of both LSG and LRYGB.

There are several limitations to this study. The MBSAQIP database only captures 30-day follow-up, and therefore, likely underestimates the true rate of morbidity and mortality. As with any retrospective database study using national databases, this study was subject to inherent biases, including patient selection bias, inaccurate coding, and missing data. There is also variability of hospital setting and quality, and surgeon's experience that are not available for adjustment. Finally, we used the data collected from accredited bariatric centers, and our results may not be representative of non-accredited institutions. Despite these limitations, this study provides a large sample size to examine the contemporary utilization and outcome of LSG versus LRYGB in an obese patient population with MetS.

Conclusions

Within the context of accredited centers, LSG is the predominant operation (59%) being performed for obese patients with MetS. Compared with LRYGB, LSG was associated with significantly lower 30-day morbidity and may explain in part to the higher utilization of LSG for this patient population. Further studies are needed to examine the long-term efficacy of LSG versus LRYGB for remission of MetS.

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