Surgical Endoscopy (2019) 33:895–903
https://doi.org/10.1007/s00464-018-6382-y

2018 SAGES ORAL

Assessing variation in technique for sleeve gastrectomy based on outcomes of surgeons ranked by safety and efficacy: a video-based study

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Received: 7 April 2018 / Accepted: 10 August 2018 / Published online: 15 August 2018

Abstract

Background Considerable technical variation exists when performing laparoscopic sleeve gastrectomy (LSG). However, little is known about which techniques are associated with optimal outcomes.

Objective To compare technical variation among surgeons with the lowest complication rates and whose patients achieved the most weight loss.

Methods Practicing bariatric surgeons ($n=30$) voluntarily submitted a video of a typical LSG performed between 2015 and 2016. Technique-specific data captured from videos and a questionnaire included bougie size, stapler vendor, number of staple loads, use of staple line reinforcement, fibrin sealant, intraoperative leak test, endoscopy, and drain placement. Surgeon-specific outcomes were obtained from cases performed by surgeons during the study period ($n=7023$) using a state-wide bariatric-specific data registry. Surgeons were ranked based on 30-day risk-adjusted surgical complication rates ("safety") and excess body weight loss (EBWL) % ("efficacy") at 1 year after surgery. Technique-specific variables were compared between surgeons ranked in the top and bottom quartile for both safety and efficacy.

Results Surgical complication rates ranged from 0 to 4.32% while EBWL varied from 45.3 to 65.3%. There was no correlation between surgeon rankings for safety and efficacy (Pearson's $r=0.063$, $p=0.741$). Surgeons ranked in the top quartile for safety and efficacy had significantly shorter mean operative times than surgeons ranked in the bottom quartile (65 min vs. 69 min, $p<0.0001$). Surgeons with the highest leak rates were more likely to use buttressing (85.7% vs 40.0%, $p=0.032$), otherwise operative techniques varied considerably.

Conclusions Technical variation appears to have minimal effect on the safety or efficacy of sleeve gastrectomy among surgeons participating in a state-wide quality improvement collaborative. Top ranked surgeons did have faster mean operative times indicating that there may be other metrics of technical quality that correlate to optimal outcomes.

Keywords Bariatric surgery · Sleeve gastrectomy · Outcomes · Complications · Technique · Video assessment

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Laparoscopic sleeve gastrectomy (LSG) is the most common bariatric procedure performed in the United States [1, 2]. Although LSG may be considered less technically challenging than gastric bypass, there remains considerable variation regarding the technical aspects of the operation [3–6]. Understanding the effect of operative technique on clinical outcomes is vital to improving quality and determining best practices. Thus far, recommendations regarding specific LSG techniques have been conflicting and it is unclear whether standardization will have an impact on outcomes.

There are several challenges to identifying best practices for operative technique in bariatric surgery. First, defining "optimal outcomes" depends on which outcome measure

is being studied and can range from complication rates (i.e. "safety") to weight loss (i.e. "efficacy"). Moreover, it is unclear if these two outcome measures correlate. Second, gathering objective data on the technical aspects of a surgical procedure can be challenging. Utilizing operative notes alone may be inaccurate, biased, or lack the technical nuances that make each procedure unique, despite their likeness on paper. Finally, correlating specific technical aspects of LSG to a single measure (i.e., leak) fails identify common practices employed by the top performing surgeons nor does it take into account surgeon experience, case volume or level of intraoperative assistance.

In this study, we aim to correlate operative technique with clinical outcomes for LSG by using surgical videos in conjunction with a statewide bariatric specific data registry. Technique-specific variables are compared between surgeons ranked in the top and bottom quartile for 30-day surgical complication rates and 1-year patient reported weight loss.

Methods

Study population

This study included surgeons who participate in the Michigan Bariatric Surgery Collaborative (MBSC), a statewide consortium that includes 38 surgical programs and 70 surgeons. Participating programs submit bariatric specific data to a clinical data registry (> 70,000 cases to date) and participate in quality improvement initiatives as well as triannual meetings. Data are abstracted by centrally trained abstractors using standardized definitions. Each participating hospital is also visited annually by external auditors to verify the accuracy and completeness of the submitted data. For this study, 30 surgeons (43%) submitted a representative video of a laparoscopic sleeve gastrectomy with all patient identifiers removed prior to submission. Video collection occurred between 2015 and 2016. The study was approved by the institutional review board of the University of Michigan for the MBSC and surgeons signed consent prior to participation.

Study design and data collected

This is an observational study evaluating operative technique of top performing surgeons using surgical videos and risk-adjusted surgeon-specific 30-day and 1-year outcomes. Participating surgeons provided information about their age, number of years performing bariatric surgery, completion of a bariatric surgery fellowship and the MBSC registry was queried to obtain data on type of surgical practice (teaching vs non-teaching hospital), surgical volume, and mean operative time for LSG. Videos were reviewed by a single surgeon (OAV) who was blinded to the surgeon performing the procedure. Technique-specific data obtained from the video included stapler vendor (Covidien, Mansfield, MA, USA and Ethicon Endo-Surgery., Cincinnati, OH, USA), number of stapler loads used to perform the LSG, use of buttressing, oversewing of the staple line, imbrication of the staple line, location of oversewing/imbricating, omentoplasty, use of fibrin sealant, intraoperative endoscopy, and use of drains. Additional information including type of assistant (i.e., surgical resident, nurse practitioner, physician assistant or surgical scrub), bougie size, and use of postoperative imaging studies were obtained via surgeon surveys.

Aggregate data from participating surgeons on 7023 sleeve gastrectomy cases were obtained from the MBSC registry during the study period (2015–2016). Data included patient characteristics, 30-day and 1-year excess body weight loss. Baseline patient characteristics included age, body mass index (BMI), gender, race, and comorbid conditions including diabetes, hyperlipidemia, hypertension, gastroesophageal reflux disease (GERD), and obstructive sleep apnea (OSA). Postoperative outcomes included 30-day surgical complication rate, which included rates of leak, hemorrhage, infection, obstruction, and reoperation. Data on excess body weight loss at 1 year were available for 3630 patients.

Analysis

We calculated risk-adjusted rates of surgical complications and %EBWL at 1-year following surgery for each surgeon, using multivariate logistic regression models for complications and a multivariate linear regression model for excess body weight loss with robust standard errors to account for clustering. Risk-adjusted rates were then calculated as the ratio of total number of observed to expected number of outcomes for each surgeon (observed-to-expected ratio) multiplied by the overall average rate of specific outcome (leak, hemorrhage, infection, obstruction, and reoperation).

We ranked the surgeons for safety using risk-adjusted outcomes of surgical complications and for efficacy using %EBWL. Individual surgeon rankings range from 1 to 30 with the lowest to highest surgical complication rates and EBWL% from highest to lowest. We looked at the correlation between surgeon safety and efficacy ranking by using Pearson correlation coefficient. Surgeons were also categorized into individual quartiles for performance based on individual measures of surgical complication rates (leak, hemorrhage, infection, obstruction, and reoperation), respectively.

We compared surgeon characteristics and technique-specific variables between top and bottom quartiles of performance using Chi square and Wilcoxon rank sum tests as appropriate. For all the specific risk-adjusted outcomes, we used logistic regression models with forward stepwise

selection using $p < 0.1$ as inclusion criteria to select other covariates (comorbidities) in addition to age, gender and BMI. All reported p values were 2-sided and a value of < 0.05 was used as threshold for significance. All statistical analyses were performed using SAS version 9.4.

Results

Patient characteristics among surgeons participating in the study are presented in Table 1. Mean age was 45.4 years and mean BMI was 47.5 kg/m^2. Surgeon rankings are presented in Fig. 1. There was no correlation between rankings for safety and efficacy (Pearson correlation coefficient, 0.063; $p = 0.741$). Surgeons ranked in the top quartile for safety had a significantly lower mean overall surgical complication rate (0.96% vs. 3.61%, $p < 0.0001$) when compared with surgeons in the bottom quartile. (Table 2). Likewise, surgeons ranked in the top quartile for efficacy had a higher mean overall EBWL% (63.0% vs. 52.0%, $p = 0.0002$). The safest and most effective surgeons also had faster mean operative times (74 min vs. 82 min, $p < 0.0001$ and 79 min vs 89 min $p < 0.0001$, respectively). However, the remaining characteristics between surgeons in the top and bottom quartiles were not significantly different (Table 3).

Table 1 Patient characteristics among participating surgeons

	Overall mean (range) or %
n	7023
Age (years)	45.4 (11.7)
BMI (kg/m^2)	47.5 (8.1)
Male (%)	20.7
White (%)	74.8
Diabetes (%)	31.1
Hyperlipidemia (%)	44.9
Hypertension (%)	50.8
GERD (%)	52.3
OSA (%)	45.3

BMI body mass index, *GERD* gastroesophageal reflux disease, *OSA* obstructive sleep apnea

Participating surgeons demonstrated a wide variety of operative techniques when performing laparoscopic sleeve gastrectomy (Fig. 2; Table 4). The number of ports ranged from 3 to 6 and bougie size ranged from 30 to 42 Fr. The number of stapler loads utilized also varied from 4 to 7. Buttressing material was utilized in 62.1% of cases and surgeons either oversewed or imbricated the staple line in 13.8% and 24.1% of cases, respectively. Location of oversewing/Imbricating also varied, as did use of fibrin sealant and intraoperative endoscopy. Drain placement (6.9%) and use of postoperative imaging studies (13.8%) was uncommon. Evaluation of technique-specific variables among surgeons in the top and bottom quartile for each individual outcome measure is presented in Table 4. Surgeons in the bottom quartile for leak had a significantly higher mean leak rate when compared to surgeons in the top quartile (1.20% vs. 0%, $p = 0.0072$) and were more likely to use buttressing material (85.7% vs. 40.0%, $p = 0.032$). Surgeons with higher leak rates also trended to using smaller bougie sizes (34 Fr

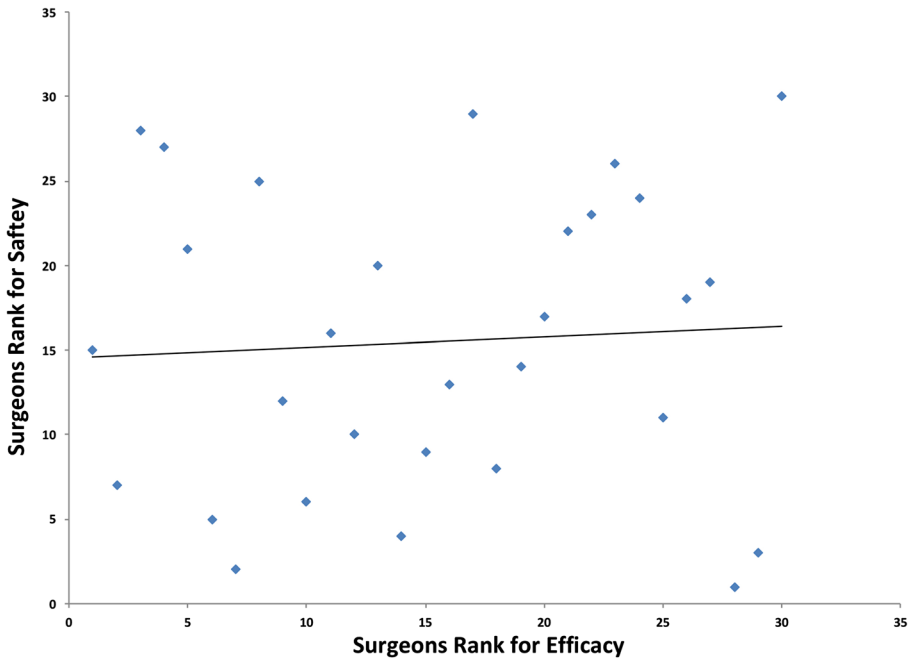

Fig. 1 Surgeon rankings for safety and efficacy. Pearson correlation coefficient, 0.063; $p = 0.741$

Table 2 Comparison of risk adjusted 30-day complication rates and risk adjusted 1-year patient reported weight loss among surgeons who were ranked in the top and bottom quartiles for both safety and efficacy

30 day risk adjusted outcomes	Overall mean (range) or %	Top quartile safety (range)	Bottom quartile safety (range)	*p* value
# of surgeons	30	7	7	
# of patients	7023	1175	1197	
Surgical complications (%)	2.22 (0–4.32)	0.96 (0–1.38)	3.61 (2.79–4.32)	< 0.0001
Leak (%)	0.40 (0–2.5)	0.16 (0–0.78)	0.89 (0–2.54)	0.125
Hemorrhage (%)	0.89 (0–2.3)	0.42 (0–1.08)	1.04 (0–2.12)	0.180
Infection (%)	0.80 (0–3.2)	0.22 (0–1.21)	1.56 (0.45–3.23)	0.014
Obstruction (%)	0.26 (0–1.3)	0 (0–0)	0.49 (0–1.16)	0.048
Reoperation (%)	0.62 (0–2.5)	0.21 (0–0.64)	1.01 (0–1.81)	0.014
1 year patient reported outcomes	Overall mean (range) or %	Top quartile efficacy (range)	Bottom quartile efficacy (range)	*p* value
# of surgeons	30	7	7	
# of patients	3630	499	606	
EBWL%	57.4 (45.3–65.3)	63.0 (61.8–65.3)	52.0 (45.3–55.4)	0.0002

EBWL excess body weight loss

Table 3 Comparison of surgeon specific characteristics among surgeons who were ranked in the top and bottom quartiles for safety and efficacy

	Overall mean (range) or %	Top quartile safety (range)	Bottom quartile saftey (range)	*p* value	Top quartile efficacy (range)	Bottom quartile efficacy (range)	*p* value
# of surgeons	30	7	7		8	8	
Age (years)	47.5 (37–74)	45.7 (38–63)	50.9 (41–74)	0.354	42.7 (38–48)	51.6 (37–74)	0.137
Years in bariatrics	12 (3–25)	12 (5–22)	15.1 (9–25)	0.288	9.4 (3–14)	14.7 (4–25)	0.152
Fellowship training (%)	39.3	71.4	14.3	0.032	57.1	42.9	0.626
Teaching Hospital (%)	69	71.4	42.9	0.317	42.9	57.1	0.626
Total LSG volume (*n*)	7.023	1.175	1.197	0.956	1.065	1.238	0.629
Annual LSG volume (*n*)	119	86	87	0.959	77	91	0.602
Mean OR time (min)	81.6 (13–508)	74 (25–229)	82 (24–463)	< 0.0001	79 (24–383)	89 (29–463)	< 0.0001

SG sleeve gastrectomy, *OR* operating room

vs. 36 Fr, $p = 0.054$). Otherwise, there were no unique technical findings among top and bottom quartiles of surgeons.

Discussion

This is the first study to use surgical videos along with a statewide bariatric-specific data registry to evaluate operative technique for laparoscopic sleeve gastrectomy. Using the MBSC collaborative quality improvement paradigm, surgeons were ranked based on risk-adjusted outcomes and outliers were compared with respect to surgeon and technique-specific variables. Interestingly, we found that rankings of surgeons based on surgical complication rates did not correlate with that of weight loss, which means that "optimal" outcomes depends on how it is defined and is not limited to the same group of surgeons. In addition, we found no correlation among surgeons in the top and bottom quartiles for safety and efficacy with respect to annual or total case volume, fellowship training, or number of years practicing bariatric surgery. Although top performing surgeons had faster operative times, there was no unique pattern of techniques to distinguish surgeons in the top and bottom quartiles for weight loss, hemorrhage infection, obstruction, or reoperation. We did find that the use of buttressing and smaller bougie sizes was more common among surgeons with higher leak rates, however, the overall rate was extremely low, which suggests that some degree of technical variation is acceptable among a group of practicing surgeons participating in a collaborative quality improvement program.

Prior studies evaluating the impact of surgical techniques on safety outcomes for LSG focused on specific adverse

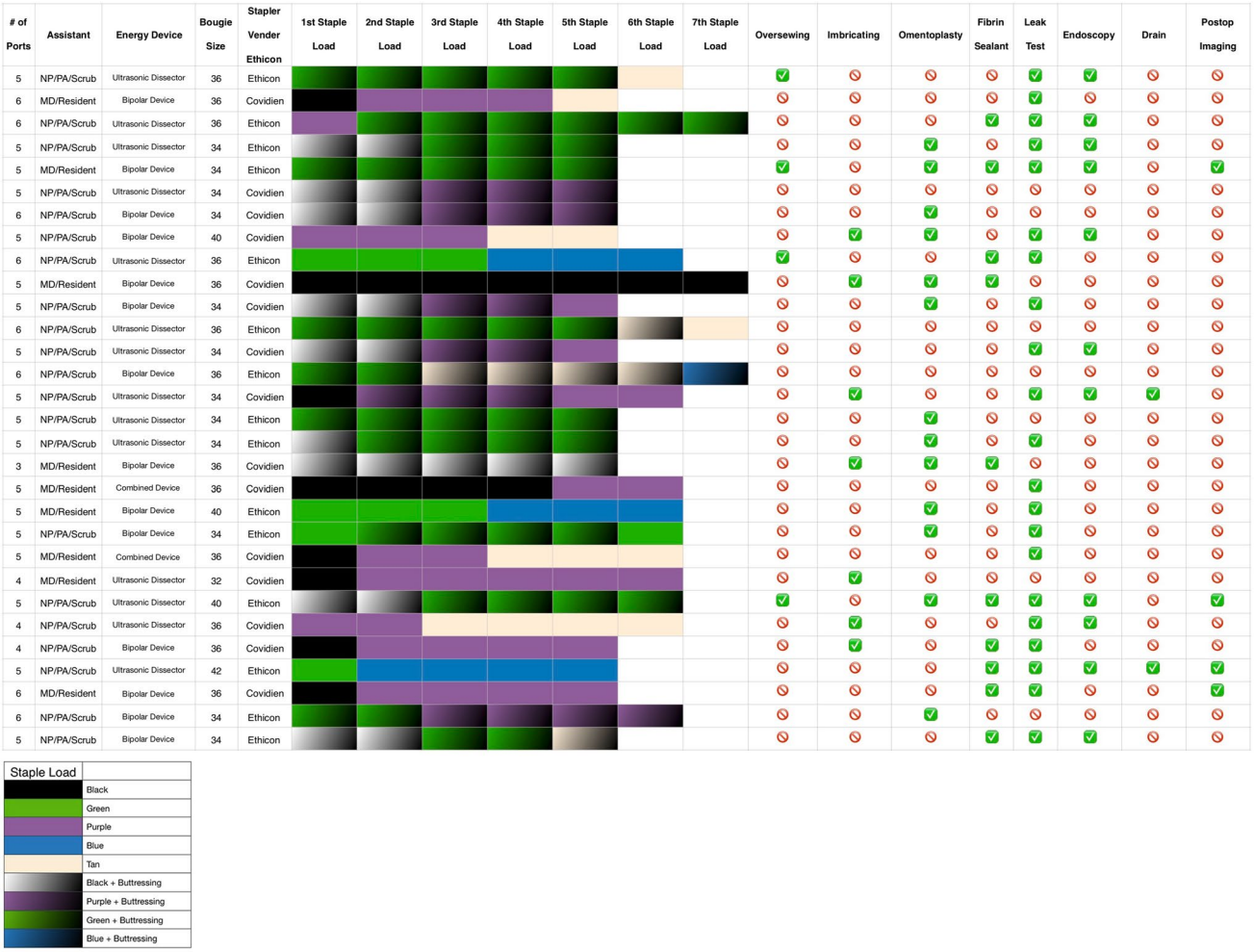

Fig. 2 Operative technique for laparoscopic sleeve gastrectomy among participants in the study. (Color figure online)

events including staple line leak and hemorrhage. Larger bougie sizes (> 40 Fr) has been advocated Aurora et al., while D'Ugo, Gagner and Gill each have recommended the use of staple line reinforcement, although the specific type of reinforcement has varied (i.e., bovine pericardium, oversewing, thrombin matrix, or absorbable polymer) [7–10]. In a prior study published by the MBSC, oversewing was noted to be associated with fewer leaks; however, specific sewing techniques varied and the overall rate of leaks decreased during the study period of 5 years [11]. Interestingly, the use of buttressing was not predictive of leaks in our prior study, which spanned from 2007 to 2013 and may represent a change in the use of buttressing over time as the present study took place between 2015 and 2016. In fact, our findings are more consistent with a recent report by Berger et al., who analyzed data from the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP) registry to assess the impact of a surgical techniques on a variety of outcome measures [4]. Their overall morbidity (4.34%), leak rate (0.9%), and bleeding rate (0.82%) was low and similar to our study. They found that bougie sizes ≥ 38 Fr was associated with lower leak rates and also found that buttressing ± oversewing was associated with increased leak rates.

Efforts toward standardization of LSG technique have been attempted in the past but lacked an evidence-based approach. In 2011, an international panel of expert bariatric surgeons who had performed a high volume of cases (> 500) was queried on specific technical considerations for LSG [5]. At the time, they recommended bougie sizes between 32 and 36 Fr and also recommended the use of staple line reinforcement to reduce bleeding along the staple line. In 2014, the survey was repeated and compared with the 2011 panel as well as survey data obtained from a general surgeon audience [12] This study highlighted areas of technical variation between experts and the general bariatric surgeon including the use of larger bougie sizes among experts (median size being 36 Fr) as well as the use of buttressing material along

Table 4 Comparison of technique-specific variables among surgeons who were ranked in the top and bottom quartiles for specific measures of safety and efficacy

	Overall mean	Hemorrhage		*p* value	Infection		*p* value	Leak		*p* value	Obstruction		*p* value	Reoperation		*p* value	EBWL%		*p* value
Quartile		Top	Bottom		Top	Bottom		Top	Bottom		Top	Bottom		Top	Bottom		Top	Bottom	
Mean rate of outcome measure (%)		0	1.88	<0.0001	0	2.00	0.0002	0	1.20	0.0072	0	0.85	0.0004	0	1.28	<0.0001	63	52	0.0002
# of surgeons	30	7	7		9	7		15	7		18	7		9	7		7	7	
Operative assistant																			
Attending/resident (%)	27.6	42.9	28.6	0.611	55.6	14.3	0.090	40.0	14.3	0.204	27.8	14.3	0.465	55.6	28.6	0.308	14.3	28.6	0.552
NP/PA/scrub (%)	72.4	57.1	71.4	0.611	44.4	85.7	0.090	60.0	85.7	0.204	72.2	85.7	0.465	44.4	71.4	0.308	85.7	71.4	0.552
# of ports (median)	5 (3–6)	5 (3–6)	5 (4–6)	1.000	5 (3–6)	5 (5–6)	0.291	5 (3–6)	5 (5–6)	0.330	5 (3–6)	5 (5–6)	0.506	5 (3–6)	5 (4–6)	0.774	5 (5–6)	5 (3–6)	0.525
Bougie size (Fr) (median)	36 (30–42)	36 (30–40)	34 (32–42)	1.000	36 (34–40)	36 (30–40)	0.760	36 (32–42)	34 (30–36)	0.054	35 (34–42)	34 (30–40)	0.949	36 (34–40)	36 (30–42)	0.871	34 (30–40)	34 (34–36)	1.000
Energy device (%)																			
Ultrasonic dissector	50.0	33.3	57.1	0.432	33.3	50.0	0.563	46.7	50.0	0.901	50.0	33.3	0.511	44.4	33.3	0.693	50.0	28.6	0.476
Bipolar device	46.4	66.7	42.9	0.432	66.7	33.3	0.242	46.7	50.0	0.901	44.4	66.7	0.385	44.4	66.7	0.435	50.0	71.4	0.476
Combined energy device	3.6	0.0	0.0	n/a	0.0	16.7	0.363	6.7	0.0	0.334	5.6	0.0	0.331	11.1	0.0	0.347	0.0	0.0	n/a
Stapler vendor (% Ethicon)	51.7	71.4	57.1	0.611	44.4	42.9	0.954	40.0	71.4	0.189	50.0	57.1	0.768	55.6	42.9	0.643	42.9	57.1	0.626
Number of staple loads (median)	5.5 (4–7)	6.5 (4–7)	6 (5–6)	0.467	5 (4–7)	6 (5–7)	0.181	5 (4–7)	6 (5–7)	0.063	5 (4–7)	6 (5–7)	0.246	5 (4–7)	6 (5–7)	0.410	5.5 (5–7)	5 (4–6)	0.244

Table 4 (continued)

	Overall mean	Hemorrhage		*p* value	Infection		*p* value	Leak		*p* value	Obstruction		*p* value	Reoperation		*p* value	EBWL%		*p* value
Use of buttressing	62.1	71.4	42.9	0.317	55.6	71.4	0.544	40.0	85.7	0.032	72.2	42.9	0.230	55.6	28.6	0.308	71.4	71.4	1.000
Oversewing (%)	13.8	28.6	0.0	0.172	11.1	14.3	0.864	13.3	14.3	0.956	11.1	14.3	0.849	22.2	0.0	0.169	28.6	0.0	0.172
Imbricating (%)	24.1	28.6	28.6	1.000	33.3	14.3	0.400	33.3	14.3	0.333	16.7	28.6	0.576	22.2	57.1	0.188	28.6	28.6	1.000
Proximal staple line (%)	17.2	14.3	14.3	1.000	11.1	14.3	0.864	20.0	14.3	0.754	11.1	14.3	0.849	11.1	14.3	0.864	14.3	0.0	0.356
Entire staple line (%)	17.2	28.6	14.3	0.552	33.3	14.3	0.400	20.0	14.3	0.754	11.1	28.6	0.407	22.2	42.9	0.426	28.6	28.6	1.000
Omentoplasty (%)	44.8	42.9	42.9	1.000	77.8	28.6	0.058	33.3	42.9	0.697	44.4	42.9	0.948	44.4	42.9	0.954	28.6	57.1	0.317
Use of fibrin sealant (%)	34.5	28.6	42.9	0.611	44.4	14.3	0.204	33.3	14.3	0.333	27.8	28.6	0.971	33.3	28.6	0.851	14.3	57.1	0.112
Intraoperative endoscopy (%)	37.9	42.9	14.3	0.273	22.2	42.9	0.426	26.7	42.9	0.504	27.8	57.1	0.230	44.4	28.6	0.544	71.4	28.6	0.126
Intraoperative leak test performed (%)	69.0	57.1	57.1	1.000	55.6	71.4	0.544	66.7	71.4	0.835	66.7	85.7	0.315	77.8	42.9	0.188	85.7	57.1	0.273
Intraoperative drain placed (%)	6.9	14.3	0.0	0.356	0.0	14.3	0.356	6.7	14.3	0.641	5.6	14.3	0.585	0.0	14.3	0.356	14.3	0.0	0.356
Postoperative imaging study performed (%)	13.8	28.6	14.3	0.552	11.1	28.6	0.436	6.7	28.6	0.298	11.1	14.3	0.849	11.1	14.3	0.864	28.6	14.3	0.552

NP nurse practitioner, *PA* physician assistant

the staple line. They noted that both experts and general bariatric surgeons oversewed the staple line and that there has been a movement toward using the appropriate staple height for the various thicknesses of the stomach. In our study, we identified expert surgeons by ranking them based on their outcomes for safety and efficacy and not simply case volume. Interestingly, when comparing surgeons in the top and bottom quartile for safety and efficacy, we found no difference in total and annual LSG volume, surgeon age, years in bariatric practice, fellowship training or if they were in private practice or at a teaching hospital. Interestingly, we did find that smaller bougie sizes and use of buttressing material was more common among surgeons with higher leak rates, which is consistent with that of the expert panel noted above. Nevertheless, we found that technical variation exists among surgeons in the MBSC and that surgeons with the best weight loss outcomes are not necessarily similar to those with the lowest surgical complications. Also, it is possible that certain techniques may improve one outcome measure, while worsening another. For instance, buttressing material was more commonly used among surgeons with higher leak rates but also among surgeons with lower hemorrhage rates (although not statistically significant). Thus, technical recommendations for standardization must be considered in the context of the outcomes being measured.

Prior studies have also evaluated more nuanced technical variables for LSG. For example, Bellanger et al., recommended minimizing the risk of creating strictures at the incisura angularis and stapling near the esophagus at the angle of His in a report evaluating 529 consecutive LSG cases without a leak [13]. With regard to stapling, Huang et al., argued that leaks can be avoided by calibrating the appropriate staple height with that of the tissue thickness in a study evaluating the range of gastric thickness in three areas of stapling during LSG [14]. We noted a high variability in staple heights as well as use of buttressing in our study. This may indicate that surgeons are making intraoperative decisions about staple height based on their best judgement of tissue thickness, despite a lack of objective evidence. Location of first staple load as measured from the pylorus has also been reported by Berger et al. [4]. They found that the distance had no impact on leaks or bleeding events but showed an increase in weight loss with increasing distance from the pylorus. Although we are capable of capturing such data from surgical videos, we recognize that measurements of distance, tissue thickness, and sleeve size may be subject to biases in perception if not measured objectively. Future studies evaluating these measures are forthcoming and will involve peer review of videos.

We recognize that there are several limitations to our study. First, not all surgeons in the MBSC participated with only 43% submitting a video. As a result, clinical outcomes and operative technique of other top performing surgeons may not be represented. Nevertheless, this study involves the largest number of sleeve gastrectomy videos reviewed for the purposes of assessing the impact of operative technique on outcomes. Furthermore, surgical complication rates and weight-loss among surgeons participating in the study are consistent with those reported in the literature, indicating that our study sample may be comparable to others. Second, 1-year weight loss data were only available for 52% of eligible patients and this may have biased weight loss results. However, perioperative 30-day outcomes were obtained on all patients in the study and case volumes between surgeons in the top and quartile were similar. Moreover, risk-adjusted outcomes were utilized when performing the analysis. We also recognize that a single video may not be representative of a surgeon's entire surgical repertoire and it may be possible that a surgeon's technique has evolved over time. For this reason, we decided only to evaluate outcomes during the study period in which the videos were collected (2015–2016). Finally, this study does not take into account variations in surgical skill, which represents how well a surgeon executed the various steps of the LSG procedure. In a prior study of patients undergoing laparoscopic Roux-en Y gastric bypass, Birkmeyer et al., identified a significant association between surgical skill and outcomes [15]. Our study found that mean operative times among top performing surgeons were significantly lower, indicating that there may be additional measures of technical quality that may be captured from surgical videos. Future studies involving peer review of videos assessing measures of surgical skill are currently being conducted.

Conclusion

Technical variation for laparoscopic sleeve gastrectomy exists among surgeons participating in a state-wide quality collaborative and appears to have minimal effect on outcomes. Top performing surgeons did have faster operative times; however, surgeon rankings of safety did not correlate with that efficacy. Further analysis of surgical videos may provide additional insight on novel measures that relate technical quality with optimal outcomes.

Funding SAGES Career Development Award 2016.

Compliance with ethical standards

Disclosures Oliver A. Varban, MD: Receives salary support from Blue Cross/Blue Shield of Michigan for leadership and participation in quality improvement initiatives within the Michigan Bariatric Surgery Collaborative. Jonathan F. Finks, MD: Receives salary support from Blue Cross/Blue Shield of Michigan for role as Associate Director of the Michigan Bariatric Surgery Collaborative. Arthur M. Carlin, MD: Receives an honorarium from Blue Cross/Blue Shield of Michigan for

Executive Committee Chair of the Michigan Bariatric Surgery Collaborative. Paul R. Kemmeter, MD Receives stipends from W. L. Gore & Associates for educational presentations. Amir (A) Ghaferi, MD, MS: Receives funding from Blue Cross/Blue Shield of Michigan for leadership in the Michigan Bariatric Surgery Collaborative. Justin (B) Dimick, MD, MPH: Receives grants and participates in NIH study sections; is an equity owner of ArborMetrix, Inc. and receives honorariums from academic health centers for giving grand rounds lectures. Jyothi R. Thumma, MPH have nothing to disclose.

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