Washington University School of Medicine
Digital Commons@Becker

2020-Current year OA Pubs Open Access Publications

10-1-2020

Assessment of postoperative nausea and vomiting after bariatric surgery using a validated questionnaire

Bradley S Kushner

Dawn Freeman

Jayme Sparkman

Arghavan Salles

J Christopher Eagon

See next page for additional authors

Follow this and additional works at: https://digitalcommons.wustl.edu/oa_4

Authors

Bradley S Kushner, Dawn Freeman, Jayme Sparkman, Arghavan Salles, J Christopher Eagon, and Shaina R Eckhouse

Surgery for Obesity and Related Diseases 16 (2020) 1505–1513

SURGERY FOR OBESITY AND RELATED DISEASES

Original article

Assessment of postoperative nausea and vomiting after bariatric surgery using a validated questionnaire

Bradley S. Kushner, M.D.[a,*], Dawn Freeman, R.N., C.B.N.[b], Jayme Sparkman, C.N.P.[a], Arghavan Salles, M.D., Ph.D.[a], J. Christopher Eagon, M.D.[a], Shaina R. Eckhouse, M.D.[a]

[a]*Section of Minimally Invasive Surgery, Department of Surgery, Washington University School of Medicine, St. Louis, Missouri*

[b]*Department of Surgery, Barnes Jewish Hospital, St. Louis, Missouri*

Received 13 January 2020; accepted 18 May 2020

Abstract

Background: Postoperative nausea and vomiting (PONV) is known to occur after bariatric surgery, with over two thirds of patients affected. However, variability exists in how to objectively measure PONV.

Objectives: The goals of the present study were to use a validated, patient-centered scoring tool, the Rhodes Index of Nausea, Vomiting, and Retching to measure the severity of PONV after bariatric surgery, to directly compare PONV between patients who underwent laparoscopic sleeve gastrectomy (LSG) and laparoscopic Roux-en-Y gastric bypass (LRYGB), and to identify risk factors for the development of PONV after bariatric surgery.

Setting: Barnes-Jewish Hospital/Washington University School of Medicine, St. Louis, Missouri, United States of America.

Methods: The Washington University Weight Loss Surgery team prospectively surveyed patients from January 1, 2017 to December 1, 2018 at the following 6 different timepoints: postoperative day (POD) 0, POD 1, POD 2, POD 3 to 4, the first postoperative outpatient visit (POV 1: POD 5–25), and the second postoperative visit (POV 2: POD 25–50). At each timepoint, a cumulative Rhodes score was calculated from the sum of 8 questions. The American Society for Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program database was used to collect patient demographic characteristics and perioperative clinical data.

Results: A total of 274 patients met study criteria and completed 605 Rhodes questionnaires. Two hundred fifty Rhodes questionnaires were completed by patients after SG and 355 were completed by patients after LRYGB. Total Rhodes scores are statistically higher in LSG patients compared with patients who underwent LRYGB (LSG = 5.45 ± 6.27; LRYGB = 3.08 ± 4.19, $P = .0002$). Additionally, at the earlier timepoints, scores were higher among patients who underwent LSG than those who had undergone LRYGB as follows: POD 0 (LSG = 6.96 ± 6.50; LRYGB = 2.89 ± 2.90, $P = .0115$), POD 1 (LSG = 8.20 ± 6.76; LRYGB = 2.88 ± 3.44, $P < .0001$), and POD 2 (LSG = 4.05 ± 4.88; LRYGB = 2.06 ± 3.43, $P = .05$). On subset analysis, examining patients who either underwent an LSG or LRYGB, both procedures had a statistically significant PONV peak emerge on POV 2. Last, overall Rhodes scores were statistically higher in female patients compared with male patients (female: 4.43 ± 5.46; male: 2.35 ± 3.90, $P = .021$). Although the magnitude of the difference varied somewhat across POD time intervals, the difference was most pronounced at POV 2.

*Correspondence: Bradley Kushner, M.D., Section of Minimally Invasive Surgery, Department of Surgery, Washington University School of Medicine, 660 S. Euclid Avenue, Campus Box 8109, Saint Louis, MO 63110.

E-mail address: b.kushner@wustl.edu (B.S. Kushner).

https://doi.org/10.1016/j.soard.2020.05.017

1550-7289/© 2020 American Society for Bariatric Surgery. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Conclusions: This is the largest study using a validated nausea and vomiting questionnaire to objectively measure PONV after bariatric surgery. The factors found to be most associated with increased PONV were LSG and female sex. Ultimately, these data can help bariatric surgery programs, including Washington University Weight Loss Surgery, identify patients who may require more intensive treatment of PONV, particularly POD 0 to 2, and help to identify patients that continue to struggle with PONV in the later surgical recovery phase. (Surg Obes Relat Dis 2020;16:1505–1513.) © 2020 American Society for Bariatric Surgery. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Key words: Postoperative nausea and vomiting; Obesity surgery; Laparoscopic sleeve gastrectomy; Roux-en-Y gastric bypass; Rhodes Index of Nausea; Vomiting; and Retching

The disease of obesity is a major public health issue [1], and bariatric surgery is its effective treatment [2]. Laparoscopic sleeve gastrectomy (LSG) and laparoscopic Roux-en-Y gastric bypass (LRYGB) are the 2 most commonly performed bariatric procedures today. While complication rates are low, postoperative nausea and vomiting (PONV) is a well-known complication after bariatric surgery, with over two thirds of patients affected [3]. Additionally, PONV leading to dehydration is the most common reason for readmission after bariatric surgery [4]. Despite the prevalence of PONV after bariatric surgery, only a few studies have previously compared the severity of nausea between the 2 most common bariatric surgical procedures, LSG and LRYGB.

Objectively measuring nausea and vomiting remains challenging, and significant variability exists in how to accurately measure PONV [3]. A number of grading and scoring tools exist to measure nausea and vomiting, such as the Functional Living Index-Emesis [5]. Still, others have studied PONV through the use of questions that yield dichotomous data in the form of yes or no answers. For example, "Are you nauseated?" or "Did you vomit [6]?" These techniques are effective at classifying patients as asymptomatic or symptomatic, but they do not adequately reflect the presence or the range of symptoms or the true scope of upper gastrointestinal discomfort [6]. While group data are appropriate for reporting the epidemiologic features of the symptoms, they are not sensitive in measuring individual change or evaluating the effectiveness of interventions [6]. Moreover, nausea, vomiting, and retching can all occur on their own and should be addressed independently [7].

The problem of measuring PONV is further complicated when one considers a clinician's perspective and preferences may differ from that of the patients. Nausea is a subjective symptom and should be evaluated by the patient and not the observer [7]. Therefore, a patient-centered scoring system, where a patient's perception, rather than the clinician's observations, are used for symptom recognition is important. Patients are more likely to prioritize their comfort and quality of recovery after surgery compared with clinicians, who may be more likely to report other serious complications that can stem from PONV rather than the severity of nausea alone [8]. Furthermore, clinical tools that facilitate the involvement of patients enhance provider-patient communication and shared decision-making that can ultimately lead to a reduction in symptom intensity and distress [9]. However, one must be careful as patient-centered scoring systems often classify patients as either asymptomatic or symptomatic and often only report nausea, vomiting, or retching and rarely report the combination of the three.

To our knowledge, there have been no studies using a validated patient-centered nausea and vomiting index to study PONV in the bariatric surgery patient population. In this study, we used the validated Rhodes Index of Nausea, Vomiting, and Retching (RINVR) [10], an 8-item questionnaire, to measure the incidence and severity of nausea, vomiting, and retching. The first iteration (INV) was created by Rhodes et al. in 1984 [6], with the goal to capture the multidimensional features of upper gastrointestinal suffering. This earlier iteration evolved to the current format with 5 possible numeric responses, the RINVR. This RINVR was further validated by Rhodes and McDaniel with high rates of agreement between the INV-2 and RINVR [6]. Ultimately, the RINVR was chosen for the present study as it has been validated in the postoperative surgical patient and can independently assess subjective and objective factors of nausea, vomiting, and retching in both a simple and reliable fashion, yet still focuses on self-reported patient symptoms [11].

The objective of the present study is 3-fold. First, our primary aim was to use the RINVR to measure the severity of PONV after bariatric surgery. Second, we sought to directly compare the severity of nausea, vomiting, and retching between patients who underwent LSG and LRYGB. Last, we sought to use these data to identify risk factors for the development of PONV after bariatric surgery. If we could identify time periods and risk factors for patients who are most affected by upper gastrointestinal suffering, we can begin to target therapeutic interventions for this patient population and reduce the number of postoperative readmissions and patient suffering.

Methods

The Washington University Weight Loss Surgery (WUWLS) team performed a prospective, cross-sectional study surveying patients postoperatively from January 2017 to December 2018. Based on the team's standard clinical practice pattern, Rhodes scores were collected at specific time points as follows: postoperative day (POD) 0, POD 1, POD 2, POD 3 to 4, postoperative clinic visit (POV) 1 and POV 2. During the patient's inpatient stay, a member of the surgical team (nurse practitioner, resident surgeon, or attending surgeon) would review each question with the patient and record their answer in a secure database. On the patient's follow-up visit, the questionnaire was completed with the help of a trained medical assistant, registered nurse, or nurse practitioner at the WUWLS clinic. Based on the final distribution of Rhodes questionnaires collected, POV 1 was defined to include observation data points from POD 5 to 25 and POV 2 was defined to include observation data points from POD 25 to 60. The Washington University institutional review board (IRB) approved the project.

Our study inclusion criteria included all patients undergoing primary LSG and LRYGB during the study period. Patients who underwent revisional surgery (i.e., conversion of LSG to LRYGB, conversion of gastric band to LRYGB, or revisional LSG or LRYGB) or primary bariatric surgery other than LRYGB or LSG (i.e., biliopancreatic diversion or gastric banding) were excluded from the present study. All patients in the study had operations performed by 1 of 3 fellowship-trained bariatric surgeons. All patients who underwent primary LSG or LRYGB were asked to respond to the Rhodes questionnaire each day they were in the hospital and during their first and second postoperative clinic visits. The data were collected and accumulated in the Health Insurance Portability and Accountability Act of 1996–compliant database, RedCap (RedCap 7.3.5, 2019; Vanderbilt University, Nashville, TN, USA).

All surgeries were completed at 1 of 2 hospitals with anesthesiologists that work with bariatric surgeons regularly and use consistent anesthetic induction strategies between cases. No preoperative antinausea or pain relief medications were used. Patients were induced with propofol and inhaled anesthetics were used for maintenance. Narcotics, most commonly fentanyl, were used intraoperatively for pain control at the discretion of the anesthesia team. Opioid adjuncts, including, but not limited to, acetaminophen, dexmedetomidine, ketamine, and gabapentin, were used in a limited fashion by the anesthesia team preoperatively and intraoperatively. All patients were placed on the same postoperative pain pathway, which included the use of a hydromorphone patient-controlled analgesia pump on POD 0 and 1 and oral narcotics (hydrocodone with acetaminophen or oxycodone with acetaminophen) on POD 2. Postoperative nausea was treated similarly among all patients as follows: 1 surgeon placed patients on standing ondansetron every 4 hours, while the other 2 surgeons offered ondansetron every 4 hours as needed. If PONV persisted, prochlorperazine sulfate and transdermal scopolamine were used as adjunctive agents.

The previously validated RINVR was used. The items in the questionnaire are shown in Table 1. At each timepoint, a total Rhodes score was calculated from the sum of the 8 RINVR questions. Total Rhodes scores were compared at 6 different timepoints as well as overall across all 6 time points, both in aggregate to look at trends over time and separately to compare LSG versus LRYGB. Patient demographic characteristics and perioperative clinical data collection, which were associated with the Rhodes scores, was done via the American Society for Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program database. Clinical data included the patient's demographic features, such as age, sex, and preoperative body mass index (BMI), the patient's main co-morbidities (gastroesophageal reflux disease, type 2 diabetes, smoking status, previous steroid use, history of previous surgery), and perioperative/operative factors, including American Society of Anesthesiologists class, drain placement, operative time, and length of inpatient stay.

Descriptive statistics on patient characteristics were separately generated for the 2 procedures (LSG and LRYGB), including mean and standard deviation (SD) for continuous characteristics and count for categoric characteristics. Two sample t test and X^2 test were used to compare continuous and categoric characteristics between the 2 procedures. Linear mixed-effects model for repeated measures was applied to analyze the Rhodes scores for effect of procedure, changes over time, and their interaction. Least square mean (LSM) was estimated for each procedure at each timepoint, as well as the Least Square Estimate (LSE) difference between the 2 procedures at each period with 95% confidence interval. Multiple comparisons were corrected for using Tukey-Kramer adjustment. Similar linear mixed-effects model for repeated-measures models are applied to identify the effect of each preoperative factor for the Rhodes scores accounting for timepoint and the interaction between the preoperative factor and the timepoint. Statistical significance was set at $P < .05$.

Results

A total of 309 patients completed 738 Rhodes questionnaires from January 2017 to December 2018. Of 309 patients who completed Rhodes questionnaires, 274 patients met study criteria and were included for analysis. From the patients who met study criteria, a total of 605 Rhodes questionnaires were completed as follows: 250 Rhodes questionnaires were completed by patients who underwent LSG, and 355 questionnaires were completed by patients who had a LRYGB. Of the total 274 patients included in

Table 1
Rhodes Index of Nausea and Vomiting

Scores	0	1	2	3	4
In the last 12 hr, I threw up __ times	I did not throw up	1–2	3–4	5–6	≥7
In the last 12 hr, from retching and dry heaves, I have felt __ distress	No	Mild	Moderate	Great	Severe
In the last 12 hr, from vomiting or throwing up, I have felt __ distress	No	Mild	Moderate	Great	Severe
In the last 12 hr, I have felt nauseated or sick to my stomach __ times	Not at all	≤1 hr	2–3 hr	4–6 hr	≥6 hr
In the last 12 hr, from nausea/sickness to my stomach, I have felt __ distress	No	Mild	Moderate	Great	Severe
In the last 12 hr, each time I threw up, I produced a __ amount	I did not throw up	Small	Moderate	Large	Very large
In the last 12 hr, I have felt nauseated or sick to my stomach __ times	No	1–2	3–4	5–6	≥7
In the last 12 hr, I have had periods of retching/dry heaves without bringing anything up __ times	No	1–2	3–4	5–6	≥7

the study, 112 patients underwent an LSG (40.8%). Patient demographic characteristics for each procedure group were similar except for preoperative rates of hyperlipidemia with higher preoperative hyperlipidemia rates in LRYGB patients (P = .0448). Perioperative characteristics were similar between procedures except for operative times, which, as expected, were statistically longer in the LRYGB population (P < .0001). Patient demographic characteristics are presented in Table 2, and perioperative characteristics are presented in Table 3.

The mean total Rhodes score for LSG is 5.45 (SD, 6.27) and for LRYGB is 3.08 (SD, 4.19). Overall, total Rhodes scores are statistically higher in the LSG group compared with the LRYGB group (F value = 14.74, P = .0002). When looking at specific timepoints where Rhodes scores were gathered, there is a statistically significant difference between the 2 procedures at the earlier visits as follows: POD 0 (LSG = 6.96 ± 6.50; LRYGB = 2.89 ± 2.90, P = .0115), POD 1 (LSG = 8.20 ± 6.76; LRYGB = 2.88 ± 3.44, P < .0001), and POD 2 (LSG = 4.05 ± 4.88; LRYGB = 2.06 ± 3.43, P = .05). There was no significant

Table 2
Baseline characteristics of bariatric surgery population

Baseline characteristic variable	Sleeve gastrectomy (n = 112)	Gastric bypass (n = 162)	*P* value
Age	44.2 ± 11.0	44.8 ± 12.0	.5958
Sex (%)			.2951
Male	16 (14.3)	31 (19.1)	
Female	96 (85.7)	131 (80.9)	
BMI	49.2 ± 10.4	49.8 ± 10.0	.645
Previous surgery (%)			.7666
Yes	4 (3.6)	8 (4.9)	
No	108 (96.4)	154 (95.1)	
Diabetes (%)			.3944
Yes	24 (22.9)	26 (18.4)	
No	81 (77.1)	115 (81.6)	
Smoker (%)			.9792
Yes	7 (6.3)	10 (6.2)	
No	105 (93.7)	152 (93.8)	
COPD			.6867
Yes	5 (4.5)	9 (5.6)	
No	107 (95.5)	153 (94.4)	
Obstructive sleep apnea (%)			.1748
Yes	46 (41.1)	80 (49.4)	
No	66 (58.9)	82 (50.6)	
GERD (%)			.1947
Yes	35 (31.3)	63 (38.9)	
No	77 (68.7)	99 (61.1)	
Hyperlipidemia (%)			.0448*
Yes	23 (20.5)	51 (31.5)	
No	89 (79.5)	111 (68.5)	
History of DVT (%)			.6487
Yes	10 (8.9)	12 (7.4)	
No	102 (91.1)	150 (92.6)	

BMI = body mass index; COPD = chronic obstructive pulmonary disease; GERD = gastrointestinal reflux disease; DVT = deep venous thrombosis.

Age and BMI are reported as a mean ± standard deviation.

* $P \leq .05$.

Table 3
Perioperative characteristics of bariatric surgery population

Perioperative characteristic	Sleeve gastrectomy (n = 112)	Gastric bypass (n = 162)	*P* value
Steroid Use			.7771
Yes	6 (5.4)	10 (6.2)	
No	106 (94.6)	152 (93.8)	
ASA classification (%)			.130
Class 2	39 (34.8)	39 (24.1)	
Class 3	68 (60.7)	117 (72.2)	
Class 4	5 (4.5)	6 (3.7)	
Drain placement (%)			.8437
Yes	3 (2.7)	5 (3.1)	
No	109 (97.3)	157 (96.9)	
Operative time	96.7 (26.2)	180 (54.8)	<.0001*
LOS	2.45 (2.1)	2.38 (.8)	.4455

ASA = American Society of Anesthesiologist; LOS = length of stay.

Operative time and LOS are reported as mean ± standard deviation.

* $P \leq .05$.

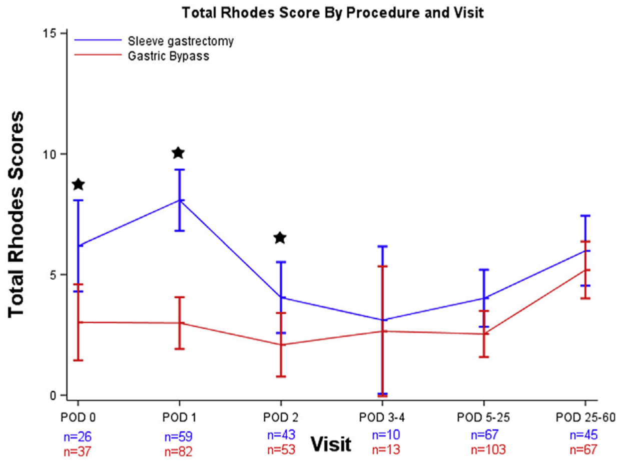

Fig. 1. This figure compares Rhodes scores between SG and RYGB at the six specific time points. There was a statistically significant difference in Rhodes scores between the two procedures at the earlier visits: POD 0 (P = .0115), POD 1 (P < .0001) and POD 2 (P = .05). There was no significant difference in Rhodes scores at the other time points (POD 3-4, P = .082; POD 5-25, P = .0563; POD 25-60, P = .39). Blue line represents Rhodes scores for SG and red line displays Rhodes scores for RYGB. *Signifies $P \leq .05$. Number of Rhodes questionnaires completed at specific visits: POD 0 (26 SG; 37 RYGB), POD 1 (59 SG; 82 RYGB), POD 2 (43 SG; 53 RYGB), POD 3-4 (10 SG; 13 RYGB), POD 5-25 (67 SG; 103 RYGB), POD 25-60 (45 SG; 67 RYGB).

difference in Rhodes scores by procedure at the other timepoints as follows: POD 3 to 4 (LSG = 2.90 ± 4.68; LRYGB = 2.85 ± 2.58, P = .082), POD 5 to 25 (LSG = 3.85 ± 4.23; LRYGB = 2.55 ± 3.49, P = .0563), and POD 25 to 60 (LSG = 5.84 +/- 8.12; LRYGB = 5.07, SD ± 6.36, P = .39) (Fig. 1 and Table 4). Analysis of total Rhodes scores by percentile also revealed a substantial difference between the 2 procedures on POD 1 as follows: the total Rhodes score for the 75th percentile for LSG patients was 13.00 compared with 5.00 for LRYGB patients. For the 95th percentile, a difference of 13 points existed between the 2 procedures (LSG: 22.00; LRYGB: 9.00) (Tables 5 and 6). Patients who do suffer from nausea, vomiting, and retching early in their postoperative course tend to experience a greater severity of these symptoms after an LSG compared with LRYGB.

For patients who underwent LSG, there were significantly higher Rhodes scores on POD 0 and 1 compared with POD 5 to 25 (t value = 1.97, LSM = 2.17, standard error [SE] = 1.20, P = .049 and t value = 4.79, LSM = 4.07, SE = .84, P < .0001, respectively) as well as a significantly higher Rhodes scores at POD 25 to 60 compared with POD 5 to 25 (t value = 2.17, LSM = 1.97, SE = .91, P = .03). Additionally, there was significantly higher Rhodes scores on POD 1 compared with POD 25 to 60 (t value = 2.22, LSM = 2.09, SE = .94, P = .03) and no difference in Rhodes scores between POD 0 and POD 25 to 60 (t value = .17, LSM = .20, SE = 1.17, P = .87) (Table 7). Among the patients who had a RYGB, patients had statistically higher Rhodes scores on POD 25 to 60 compared with POD 0, POD 1, POD 2, and POD 5 to 25 (t value = 2.23, LSM = 2.17, SE = .97, P = .026; t value = 2.8, LSM = 2.20, SE = .78, P = .005; t value = 3.55, LSM = −3.10, SE = .87, P = .0004; t value = 3.6, LSM = 2.65, SE = .74, P = .0003, respectively) (Table 7). Thus, for those who underwent LSG, scores were highest on POD 0 and 1 with a second peak at POD 25 to 60. Those who underwent LRYGB experienced the most symptoms of nausea, vomiting, and retching around POD 25 to 60.

The only preoperative risk factor independently associated with increased Rhodes scores (Table 8) was female sex. Across all timepoints, total Rhodes scores were statistically higher in female patients compared with male patients (female: 4.43 ± 5.46; male: 2.35 ± 3.90, P = .021). The difference in Rhodes score by sex was most pronounced at POV 2 (female patients experience more gastrointestinal suffering at POV 2 compared with their male counterparts) (female: 6.12 ± 7.56; male: 2.19 ± 3.09, P = .0008). Age, preoperative BMI, gastroesophageal reflux disease, type 2 diabetes, smoking, previous steroid use, and history of previous surgery were not independently associated with higher Rhodes scores (Table 8). The only perioperative characteristic that was independently associated with a higher Rhodes score was a shorter length of surgery (LSG: 96.7 ± 26.2 min; LRYGB: 180 ± 54.48 min; P < .0001). Preoperative

Table 4
Comparing sleeve gastrectomy to gastric bypass total Rhodes scores

Postoperative time period (POD)	LSM estimate difference (SG-RYGB)	Standard error	95%CI lower limit	95%CI upper limit	t value	P value
POD 0	3.17	1.25	5.62	.72	2.54	.01*
POD 1	5.09	.84	6.75	3.43	6.03	<.0001*
POD 2	1.96	1.00	3.93	−.01	1.95	.05*
POD 3–4	.46	2.07	4.53	−3.60	.22	.82
POD 5–25	1.48	.77	3.00	−.04	1.91	.06
POD 25–60	.80	.95	2.66	−1.06	.84	.40

POD = postoperative day; LSM = least square mean; SG = sleeve gastrectomy; RYGB = Roux-en-Y gastric bypass; CI = confidence interval.
Scores are the differences of the least square mean estimates between procedures during the postoperative time period.
* $P \leq .05$.

Table 5
Mean Rhodes score by percentile and by sleeve gastrectomy

Visit	# Questionnaires	Mean	SD	10th	25th	50th	75th	95th
POD 0	26	5.96	6.50	.00	.00	4.50	7.00	21.00
POD 1	59	8.20	6.76	.00	2.00	7.00	13.00	22.00
POD 2	43	4.05	4.88	.00	.00	2.00	6.00	14.00
POD 3–4	10	2.90	4.68	.00	.00	1.00	2.00	13.00
POD 5–25	67	3.85	4.23	.00	.00	2.00	6.00	11.00
POD 25–60	45	5.84	8.12	.00	.00	3.00	7.00	22.00

POD = postoperative day.
10th, 25th, 50th, 75th, and 95th refer to the 10th, 25th, 50th, 75th, and 95th percentile, respectively.

American Society of Anesthesiologists class and length of inpatient stay were not associated with higher Rhodes scores (Table 8). On subset analysis (i.e., analyzing perioperative risk factors independently for LSG and LRYGB), we found no statistical association in total Rhodes scores with length of inpatient stay, operative time, or American Society of Anesthesiologists class for either the LSG or LRYGB. However, female patients who underwent LRYGB had statistically higher total Rhodes scores over all time periods compared with males (female: 3.37 ± 4.38; male: 1.89 ± 3.09, P = .0266). While there was trend to higher Rhodes scores in females who underwent LSG, this difference was ultimately not statistically significant (female: 5.79 ± 6.37; male: 3.29 ± 5.11, P = .1526).

Discussion

Evaluation of PONV continues to remain a crucial, yet challenging issue after bariatric surgery, and complications secondary to PONV are the most common cause for readmission in the first 30 postoperative days. Nevertheless, few studies have examined the rates of PONV between the 2 most common bariatric procedures performed in the United States. The objective of the present study was to use a patient-centered, validated nausea, vomiting, and retching questionnaire to compare PONV in the 2 most commonly performed bariatric surgeries. The findings of the present study were 3-fold. PONV, as determined by Rhodes scores, was greater in patients who underwent LSG compared with LRYGB. Additionally, patients experienced peak symptoms either early on after surgery (POD 0, 1, and 2) or around the time of POV 2 (days 25–60). Those who had an LSG were more likely to be symptomatic in the early postoperative period and on POV 2, while those who underwent LRYGB were more likely to be symptomatic around the time of POV 2. Last, overall, female sex was an independent risk factor for PONV. This sex discrepancy was most pronounced among those who underwent LRYGB. To date, this is the largest systematic study of a validated PONV score in bariatric patients to objectively measure nausea, vomiting, and retching after bariatric surgery.

Overall Rhodes scores were significantly higher in LSG patients compared with LRYGB patients suggesting greater rates of PONV in this group. This effect was most pronounced in the early postoperative time period (POD 0–2: inpatient stay), and the differences between the 2 groups were smaller at the time of follow-up visits. Previous studies comparing rates of PONV after LSG and LRYGB are mixed. A recent study published by Celio et al. [4], prospectively examining a cohort of 65 patients, found no difference in early PONV between the 2 groups. Although this group used a patient-centered scoring tool, the tool had not been previously validated in a postoperative surgical patient population like the Rhodes score [6]. Other groups have found LSG patients struggle with PONV early in their postoperative course. For instance, Major et al. [12] found a significantly greater rate of PONV in LSG patients compared with LRYGB and an increased need for intravenous fluids

Table 6
Mean Rhodes score by percentile and by Roux-en-Y gastric bypass

Visit	# Questionnaires	Mean	SD	10th	25th	50th	75th	95th
POD 0	37	2.89	2.90	.00	.00	4.00	5.00	8.00
POD 1	82	2.88	3.44	.00	.00	2.00	5.00	9.00
POD 2	53	2.06	3.43	.00	.00	.00	3.00	8.00
POD 3–4	13	2.85	2.58	.00	.00	3.00	5.00	8.00
POD 5–25	103	2.55	3.49	.00	.00	1.00	4.00	10.00
POD 25–60	67	5.07	6.36	.00	.00	4.00	6.00	16.00

POD = postoperative day.
10th, 25th, 50th, 75th, and 95th refer to the 10th, 25th, 50th, 75th, and 95th percentile, respectively.

in the first 24 hours postoperatively [12]. We hypothesize this may be related to the physiology of the LSG as the LSG is associated with increased intragastric pressure, decreased lower esophageal sphincter pressure, and increased esophageal acid exposure [13,14]. Further studies are needed to correlate these physiologic findings with PONV.

For both LSG and LRYGB patients, a PONV peak occurred around the second postoperative visit (∼5–6 wk postoperatively). Prior researchers have examined early PONV. For example, Halliday et al. [3] found PONV was worse in the first 24 hours and slowly improved over the next 4 days. However, few studies have examined nausea, vomiting, and retching past the initial inpatient hospital stay with most data analysis culminating at 30 days. Interestingly, our data suggest these symptoms recur as a significant problem 1 to 2 months after surgery in patients undergoing both LSG and LRYGB, which requires further research attention. It is possible that as patients begin their diet advancement and begin to experiment with food, they may overestimate their capabilities or revert to old habits with the consumption of heavy meals. This may also be the time when patients develop stomal stenosis or sleeve stenosis relating to postoperative edema and healing. This second observed nausea, vomiting, and retching peak shows the importance of frequent, close follow-up with patients and continued education and support.

Female sex was associated with statistically higher Rhodes scores suggesting increased PONV in female patients after bariatric surgery. Apfel et al. [15] were the first to identify female sex as a risk factor for nausea and vomiting in the bariatric surgery population. Although the reason behind this effect remains unclear, being able to target at-risk patients (females) can help ensure the return of key postoperative bariatric functions, oral fluid intake, protein intake, and exercise while guaranteeing an early, safe discharge [12]. Interestingly, on subgroup analysis, the sex discrepancy was most pronounced in the LRYGB population, with higher Rhodes scores in female patients across all 6 timepoints (although the difference was only

Table 7
Comparing Rhodes scores at different postoperative time periods for both SG and RYGB

POD	LSM estimate difference	Standard error	95%CI lower limit	95%CI upper limit	*t* value	*P* value
	Sleeve gastrectomy					
POD 0 versus POD 1	−1.89	1.10	−4.06	.28	−1.72	.09
POD 0 versus POD 2	2.14	1.16	−.14	4.42	1.85	.07
POD 0 versus POD 3–4	3.07	1.79	−.43	6.59	1.72	.09
POD 0 versus POD 5–25	2.17	1.10	.002	4.34	1.97	.05*
POD 0 versus POD 25–60	.20	1.17	−2.11	2.50	.17	.87
POD 1 versus POD 2	4.04	.92	2.22	5.85	4.37	<.01*
POD 1 versus POD 3–4	4.97	1.65	1.72	8.22	3.00	.01*
POD 1 versus POD 5–25	4.07	.84	2.40	5.73	4.79	<.01*
POD 1 versus POD 25–60	2.09	.94	.24	3.94	2.22	.03*
POD 2 versus POD 3–4	.93	1.69	−2.39	4.26	.55	.58
POD 2 versus POD 5–25	.03	.93	−1.79	1.85	.03	.97
POD 2 versus POD 25–60	−1.94	1.01	−3.92	.04	−1.93	.05*
POD 3–4 versus POD 5–25	−.90	1.64	−4.13	2.33	−.55	.58
POD 25–60 versus POD 3–4	2.88	1.68	−.42	6.17	1.72	.09
POD 25–60 versus POD 5–25	1.97	.91	.19	3.76	2.17	.03*
	Gastric bypass					
POD 0 versus POD 1	.03	.93	−1.79	1.85	.03	.98
POD 0 versus POD 2	.93	1.01	−1.05	2.92	.92	.36
POD 0 versus POD 3–4	.37	1.56	−2.70	3.43	.24	.81
POD 0 versus POD 5–25	.48	.91	−1.31	2.27	.53	.60
POD 0 versus POD 25–60	−2.17	.97	−4.08	−.26	−2.23	.03*
POD 1 versus POD 2	.90	.81	−.69	2.50	1.12	.26
POD 1 versus POD 3–4	.34	1.45	−2.51	3.20	.24	.81
POD 1 versus POD 5–25	.45	.70	−.92	1.83	.65	.52
POD 1 versus POD 25–60	−2.20	.78	−3.74	−.66	−2.80	<.01*
POD 2 versus POD 3–4	−.56	1.50	−3.50	2.38	−.38	.71
POD 2 versus POD 5–25	−.45	.80	−2.02	1.12	−.56	.57
POD 2 versus POD 25–60	−3.10	.87	−4.82	−1.39	−3.55	.01*
POD 3–4 versus POD 5–25	.11	1.44	−2.72	2.94	.08	.94
POD 25–60 versus POD 3–4	2.54	1.48	−.37	5.45	1.71	.08
POD 25–60 versus POD 5–25	2.65	.74	1.21	4.10	3.60	<.01*

SG = sleeve gastrectomy; RYGB = Roux-en-Y gastric bypass; POD = postoperative day; LSM = least square mean; CI = confidence interval.
Scores are the differences of the least square mean estimates between postoperative time periods for each procedure.
* $P \leq .05$.

Table 8
Preoperative and perioperative risk factors associated with higher Rhodes scores

Independent variable	*F* value	*P* value
Female sex	5.38	.02*
Age	2.44	.12
Preoperative BMI	.68	.41
GERD	1.49	.22
Type 2 diabetes	.08	.77
Smoking	1.03	.31
Previous steroid use	.03	.87
History of previous surgery	.02	.88
ASA class	.12	.88
Length of inpatient stay	.86	.35
Operative time	7.59	<.01*

BMI = body mass index; GERD = gastroesophageal reflux disease; ASA = American Society of Anesthesiology.
* $P \leq .05$.

statistically significant at POV 2). Although this trend was also found in the SG patients, this difference between men and women's scores was not statistically significant. The finding that PONV has a greater sex discrepancy in the LRYGB compared with LSG is a new finding and should be explored in future research.

Although total Rhodes scores for LSG (5.45) and for LRYGB (3.08) are statistically significantly different, defining whether this difference is clinically significant is more challenging. If one were to review the RINVR questionnaire (Table 1), we see that the difference in total Rhodes scores (2.37) between LSG and LRYGB patients roughly correlate to that of each LSG patient answering a point higher on 2 to 3 of the total 8 questions. For example, instead of vomiting "1 to 2" times in the last 12 hours, a SG patient may report vomiting "3 to 4" times. Alternatively, instead of feeling "nauseated" <1 hour in the last 12 hours, he or she felt nauseated for 2 to 3 hours. To the authors, this finding is clinically significant. Alternatively, if one were to examine the Rhodes scores quartile data, there is a marked difference in total Rhodes scores between the 2 groups. The Rhodes score for the 75th percentile on POD 1 for LSG patients was 13.00 compared with 5.00 for LRYGB patients. This difference of 8 points translates, on average, to each LSG patient rating their suffering 1 point higher on each question of the RINVR questionnaire. Furthermore, the sickest LSG patients are suffering more intensely than the sickest LRYGB patients. There is a large difference on POD 1 between the 2 procedures for the 95th percentile (mean Rhodes score: LSG, 22.00 versus RYGB, 9.00) and this difference is certainly clinically meaningful.

It remains clear that PONV remains a challenging and frequent problem after bariatric surgery. In response to our findings, the WUWLS team has implemented a multimodal pain and nausea pathway to attempt to reduce PONV. Because of the data described in this study, WUWLS is pretreating all bariatric surgery patients with a scopolamine patch and oral aprepitant, counseling at risk patients (females and LSG) preoperatively for signs and symptoms of postoperative dehydration, and providing prophylactic nonopioid analgesic medications preoperatively in the holding area (acetaminophen, gabapentin, and celecoxib) in attempt to cut down on postoperative opioid use, which may exacerbate PONV. Intraoperatively, we have worked with the anesthesia team to decrease use of opioids by increasing use of nonopioid medications, such as ketamine and magnesium intravenously. Postoperatively, we have discontinued the routine use of a patient-controlled analgesia on POD 0 and 1, instituted a standardized multimodal approach for pain control (acetaminophen, celecoxib, cyclobenzaprine, hyoscyamine, and breakthrough oxycodone if needed) and nausea (continued transdermal scopolamine, scheduled ondansetron, and breakthrough prochlorperazine). At discharge, our team is contacting high-risk patients regularly and scheduling follow-up clinic visits more frequently, especially between POV 1 to 2 timeframe, to better identify patients who may be struggling with late PONV and may be at risk for readmission for intravenous nutrition and hydration. The findings of the present study have led to meaningful changes in the perioperative care of patients undergoing bariatric surgery at WUWLS to decrease PONV.

There are several other future directions that should be addressed. While the Rhodes score has been validated and remains short at only 8 questions, it can remain challenging for patients to complete, especially in the immediate postoperative recovery period. Ideally, a shorter validated nausea, vomiting, and retching questionnaire that could quantify patient symptoms and directly target bariatric specific factors should be created. Additionally, while the present study is 1 of only a few that examined PONV extending to even the second postoperative visit, further work should be done to better map out this second peak in nausea, vomiting, and retching. It is possible targeted, short, and frequent patient education sessions or follow-up in the first 3 months postoperatively could help to manage these symptoms.

A potential limitation of our study was that not all patients completed the same number of Rhodes questionnaires and the timepoints at which they were completed, especially during clinic visits, were not always consistent. The authors attempted to correct for this by plotting a frequency graph and using this to determine timepoints that made clinical sense in our practice.

Conclusions

To date, this is the largest study using a validated questionnaire, the RINVR, to objectively measure PONV after bariatric surgery. The factors found to be most associated with PONV were SG and female sex. For patients undergoing LSG, we found that there appeared to be the following 2 PONV peaks: the immediate postoperative inpatient stay (POD 0–2) and the second follow-up visit. Patients who underwent a RYGB had significantly worse PONV on their second POV. Sex discrepancy of PONV was most pronounced in RYGB patients. These data may help bariatric surgery programs, including WUWLS, identify and counsel patients who may require more intensive treatment of PONV, particularly POD 0, POD 1, and in the later surgical recovery phase.

Disclosures

Dr. Eckhouse is a consultant for Gore Medical. The other authors have no commercial associations that might be a conflict of interest in relation to this article.

Acknowledgments

The authors of this manuscript would like to thank the Washington University in St. Louis Division of Biostatistics for their help in the preparation of this manuscript. The authors would also like to acknowledge Belinda Henriksen, M.S.N., A.C.N.P.-B.C., Katherine Henslee, F.N.P., and Ashley Waldrop, C.B.N. for their help in collecting RINVR questionnaires.

References

[1] Mechanick JI, Youdim A, Jones DB, et al. Clinical practice guidelines for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient–2013 update: cosponsored by American Association of Clinical Endocrinologists, The Obesity Society, and American Society for Metabolic & Bariatric Surgery. Obesity (Silver Spring) 2013;21(Suppl 1):S1–27.

[2] Wolfe BM, Kvach E, Eckel RH. Treatment of obesity: weight loss and bariatric surgery. Circ Res 2016;118(11):1844–55.

[3] Halliday TA, Sundqvist J, Hultin M, Wallden J. Post-operative nausea and vomiting in bariatric surgery patients: an observational study. Acta Anaesthesiol Scand 2017;61(5):471–9.

[4] Celio A, Bayouth L, Burruss MB, Spaniolas K. Prospective assessment of postoperative nausea early after bariatric surgery. Obes Surg 2019;29(3):858–61.

[5] Molassiotis A, Coventry PA, Stricker CT, et al. Validation and psychometric assessment of a short clinical scale to measure chemotherapy-induced nausea and vomiting: the MASCC antiemesis tool. J Pain Symptom Manage 2007;34(2):148–59.

[6] Fetzer SJ, Hand MC, Bouchard PA, Smith H, Jenkins MB. Evaluation of the Rhodes Index of Nausea and Vomiting for ambulatory surgery patients. J Adv Nurs 2004;47(1):74–80.

[7] Apfel CC, Roewer N, Korttila K. How to study postoperative nausea and vomiting. Acta Anaesthesiol Scand 2002;46(8):921–8.

[8] Wengritzky R, Mettho T, Myles PS, Burke J, Kakos A. Development and validation of a postoperative nausea and vomiting intensity scale. Br J Anaesth 2010;104(2):158–66.

[9] Wood JM, Chapman K, Eilers J. Tools for assessing nausea, vomiting, and retching. Cancer Nurs 2011;34(1):E14–24.

[10] Rhodes VA, McDaniel RW. The Index of Nausea, Vomiting, and Retching: a new format of the lndex of Nausea and Vomiting. Oncol Nurs Forum 1999;26(5):889–94.

[11] Kim THCB, Chin JH, Lee MS, Kim DH, Noh GJ. The reliability and validity of the Rhodes Index of Nausea, Vomiting and Retching in postoperative nausea and vomiting. Korean J Anesthesiol 2007;52(6):S59–65.

[12] Major P, Stefura T, Malczak P, et al. Postoperative care and functional recovery after laparoscopic sleeve gastrectomy vs. laparoscopic Roux-en-Y gastric bypass among patients under ERAS protocol. Obes Surg 2018;28(4):1031–9.

[13] Mion F, Tolone S, Garros A, et al. High-resolution impedance manometry after sleeve gastrectomy: increased intragastric pressure and reflux are frequent events. Obes Surg 2016;26(10):2449–56.

[14] Burgerhart JS, Schotborgh CA, Schoon EJ, et al. Effect of sleeve gastrectomy on gastroesophageal reflux. Obes Surg 2014;24(9):1436–41.

[15] Apfel CC, Greim CA, Haubitz I, et al. A risk score to predict the probability of postoperative vomiting in adults. Acta Anaesthesiol Scand 1998;42(5):495–501.