



Evaluation of the rate of marginal ulcer formation after bariatric surgery using the MBSAQIP database

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Abstract

Background Marginal ulcer (MU) formation is a known problem after gastric bypass. The Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP) database contains data from all US and Canadian Centers of Excellence including complication rates. We hypothesized that the short-term rate of ulceration is low.

Methods We queried the MBSAQIP database for the year 2015. We searched patients with primary gastric bypass who developed MU. We then compared preoperative, operative, and postoperative characteristics with patients who did not develop MU.

Results The incidence of MU in the entire cohort of GB patients was 155 of 44,379 (0.35%, 95% CI 0.297%, 0.409%). Among the 155 patients with an ulcer, 88 (57%) patients had only one procedure, 69 had an intervention (therapeutic or diagnostic endoscopy), 16 had readmission, and 3 had reoperation. 65 patients (42%) had two procedures with the majority having both readmissions and endoscopy ($n=59$); and two patients (1%) had three procedures. Ulcer formation was most common in the intervention group (11.4%). The occurrence of ulcer formation was associated with unplanned ICU admissions (6.45%), transfusions (5.16%), postoperative UTI (3.87%), sepsis (1.94%), and myocardial infarction (0.65%). Death occurred in 76 patients with no related cases to MUs. The risk of ulcer was associated with increased BMI (OR 1.02, $p=0.01$), presence of percutaneous transluminal cardiac catheterization (PTC) (2.17, $p=0.038$), histories of DVT (1.72, $p=0.085$), and pulmonary embolism (2.84, $p=0.002$).

Conclusions In a nationally reported database, symptomatic MUs rarely occur in the first month. The large majority are diagnosed and treated endoscopically with minimal need for surgical intervention. The risk of anastomotic ulcer was increased with increased BMI, need for PTC, and history of DVT/PE.

Keywords Marginal ulcer · Anastomotic ulcer · Gastric bypass · MBSAQIP database

Gastric bypass (GB) is the second most common bariatric operation in the United States. The sleeve gastrectomy (SG) has surpassed it in volume, at a ratio of approximately two to one [1]. The GB and SG have near equivalent rates of perioperative complications, but there are some long-term complications associated with the GB that are not seen in the SG [2, 3]. These include small bowel obstruction, internal hernia formation, and marginal ulcer (MU) formation. MU are ulcers near the gastrojejunal anastomosis which can

present with a myriad of symptoms ranging from epigastric pain and dysphagia to fatal perforation and hemorrhage [4, 5].

The rate of ulcer formation after surgery is variable and a wide range of incidence is reported in the surgical literature [6]. There are several theories regarding the formation of MU but the exact mechanism is unknown. There seems to be a difference between MU in the early postoperative period (< 30 days) and those that occur later (> 30 days). Additionally, some evidence suggests that early MUs (< 30 days) may be part of normal wound healing and only a small percentage become symptomatic. The objective of this paper is to determine the rate of symptomatic MU after GB in the early postoperative period at the national level [7].

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Methods

Database

We queried the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP) database for the year 2015. The MBSAQIP of the American College of Surgeons is a nationwide prospective database that contains data from every accredited center for bariatric surgery in the United States and Canada. It is the largest bariatric-specific registry in the US and contains Health Insurance Portability and Accountability Act compliant patient level data on more than 150,000 patients that are operated on yearly. This database includes patients that underwent metabolic or bariatric surgery and reports 30-day outcomes. The MBSAQIP hospitals participating in the MBSAQIP are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors.

Patient population

Patients undergoing GB were identified using the specified Current Procedural Terminology codes of 43644 and 43645. Eligibility criteria included patients that underwent primary GB and patients over the age of 18. Exclusion criteria were previous obesity surgery and foregut surgery. Patient characteristics examined included age, body mass index, and diagnoses regarding complications. We examined readmission rates in patients with MU, reoperations, and interventions (defined as diagnostic or therapeutic endoscopy, intraluminal procedures, placement of percutaneous drain, and inferior vena cava filter replacement or retrieval). The overall rate of complications for the bypass cohort was also examined, as well as death rates.

Outcome measures

The primary outcomes that were examined were 30 day outcomes for MU, hemorrhage, and other complications: acute renal failure, deep incisional surgical site infection (SSI), myocardial infarction (MI), unplanned admission to the intensive care unit (ICU), pneumonia, pulmonary embolism, unplanned intubation, cardiac arrest requiring cardiopulmonary resuscitation (CPR), transfusion intra or postoperatively, urinary tract infection (UTI), the number of times on ventilator > 48 h, and sepsis. The secondary outcomes were readmissions, reinterventions (endoscopy), and also reoperations. If a patient had more than one reintervention or reoperation, this was also included.

Statistical analysis

The overall incidence of ulcer was estimated along with the 95% confidence interval (CI) using the binomial distribution in the entire cohort and also separately for metabolic and bariatric procedures. Quantitative variables were described using mean and standard deviation (SD). Categorical variables were described using frequencies and proportions. The rare logistic regression was employed to determine factors associated with the occurrence of ulcer. The results of the rare logistic regression were reported using odds ratio (OR), 95% confidence interval (CI), and a *p* value. *p* values < 5% were regarded as statistically significant results. All analyses were done using SAS 9.4 (SAS Institute Inc., Cary, NC, USA) and STATA 13 (Stata Corp).

Results

There were 168,093 patients in the 2015 MBSAQIP database. Among this cohort, 53,255 patients had undergone GB. A total of 44,379 patients were included in the analysis with 8821 excluded patients due to repeat procedures and age < 18. The average age and BMI of the included subjects in this study were 45 years and 45.9 kg/m², respectively, with majority being females (80%). Most of the patients were white (76.2%) and non-Hispanic. Sixty-two percent had no history of gastroesophageal reflux and 91.5% of patients were non-smokers. Less than 2% of patients had an inferior vena cava filter (Table 1).

The incidence of ulcer in the entire cohort was 155 out of 44,379 (0.35%, 95% CI 0.297%, 0.409%). Among the 155 patients with ulcer, 88 (57%) patients had only one procedure, 69 had an intervention (therapeutic or diagnostic endoscopy), 16 were readmitted, and 3 had a reoperation. Sixty-five (42%) patients had two procedures with the majority having both readmissions and endoscopy (*n* = 59); and two patients (1%) had three procedures (Table 2). The incidence of readmission, intervention, and reoperation within 30 days were 6.5%, 2.8%, and 2.6%, respectively. The identification of MU was mainly by endoscopy (44.5), but also by reoperation (10.3%) (Table 3).

Factors that were found to be different at baseline had OR reported and adjusted for in the multivariate model. There were no statistically significant differences in age, albumin and hematocrit levels, gender, Hispanic origin, gastroesophageal reflux disease (GERD), MI, hypertension (HTN), diabetes (DM), chronic obstructive pulmonary disease (COPD), and inferior vena cava (IVC) filter. However, patients with MU were more likely to have a higher BMI, have longer operating times (123 min vs. 131 min), experience a DVT (OR 2.79), have therapeutic anticoagulation (OR 2.41), be oxygen

Table 1 Summary descriptive of patient's baseline characteristic in entire cohort, and comparison of these characteristics by presence of MU

Factor	Cohort <i>n</i> = 44,379 (%)	Ulcer present		OR (95% CI)	<i>p</i> value
		No <i>n</i> = 44,224 (%)	Yes <i>n</i> = 155 (%)		
Age (years): mean (SD)	45.41 (11.9)	45.41 (11.9)	44.6 (11.6)		0.38
Albumin: mean (SD)	2.99 (1.78)	2.99 (1.78)	2.95 (1.78)		0.75
HCT: mean (SD)	36.42 (13.12)	36.42 (13.13)	37.52 (11.89)		0.35
BMI (kg/m ²): mean (SD)	45.85 (9.14)	45.85 (9.14)	47.93 (10.28)	1.02 (1.01, 1.04)	0.004
Days to reoperation: median (IQR)	5 (2, 13)	5 (2, 13)	21 (10, 27)	1.04 (1.02, 1.06)	<0.001
Days to readmission: median (IQR)	11 (5, 18)	10 (5, 18)	20 (12, 26)	1.09 (1.07, 1.12)	<0.001
Days to intervention: median (IQR)	17 (5, 25)	16 (4, 25)	21 (13, 27)	1.11 (1.06, 1.17)	<0.001
Operation length (min): mean (SD)	122.88 (56.9)	122.85 (56.9)	131.06 (60.9)	1.002 (1, 1.005)	0.044
Sex					
Female	35,526 (80.1%)	35,402 (80.1%)	124 (80.0%)		
Male	8853 (19.9%)	8822 (19.9%)	31 (20.0%)		0.94
Race					
Black or African American	6463 (14.6%)	6432 (14.5%)	31 (20.0%)	Reference	
Others	547 (1.2%)	546 (1.2%)	1 (0.6%)	0.62 (0.08, 4.52)	0.63
Unknown/not reported	3322 (7.5%)	3320 (7.5%)	2 (1.3%)	0.16 (0.04, 0.66)	0.011
White	34,047 (76.7%)	33,926 (76.7%)	121 (78.1%)	0.73 (0.49, 1.09)	0.12
Hispanic					
No	35,044 (79.0%)	34,911 (78.9%)	133 (85.8%)		
Unknown	4080 (9.2%)	4070 (9.2%)	10 (6.5%)		0.23
Yes	5255 (11.8%)	5243 (11.9%)	12 (7.7%)		0.12
Gastroesophageal reflux disease					
No	27,465 (61.9%)	27,372 (61.9%)	93 (60.0%)		
Yes	16,914 (38.1%)	16,852 (38.1%)	62 (40.0%)		0.62
Myocardial infarction history					
No	43,680 (98.4%)	43,528 (98.4%)	152 (98.1%)		
Yes	699 (1.6%)	696 (1.6%)	3 (1.9%)		0.52
Preoperative hypertension					
No	20,711 (46.7%)	20,642 (46.7%)	69 (44.5%)		
Yes	23,668 (53.3%)	23,582 (53.3%)	86 (55.5%)		0.6
Diabetes					
Treated with insulin	6169 (13.9%)	6141 (13.9%)	28 (18.1%)	Reference	
Not treated with insulin	29,257 (65.9%)	29,163 (65.9%)	94 (60.6%)	0.70 (0.46, 1.07)	0.096
Treated with non-insulin agents	8953 (20.2%)	8920 (20.2%)	33 (21.3%)	0.81 (0.49, 1.34)	0.41
Smoker					
No	40,613 (91.5%)	40,475 (91.5%)	138 (89.0%)		
Yes	3766 (8.5%)	3749 (8.5%)	17 (11.0%)		0.23
Chronic obstructive pulmonary disease					
No	43,429 (97.9%)	43,279 (97.9%)	150 (96.8%)		
Yes	950 (2.1%)	945 (2.1%)	5 (3.2%)		0.26
Inferior vena cava filter					
No	43,866 (98.8%)	43,713 (98.8%)	153 (98.7%)		
Yes	513 (1.2%)	511 (1.2%)	2 (1.3%)		0.62
Reoperation in the 30-day period?					
No	43,246 (97.4%)	43,108 (97.5%)	138 (89.0%)	Reference	
Yes	1133 (2.6%)	1116 (2.5%)	17 (11.0%)	4.88 (2.94, 8.11)	<0.001
Readmission in the 30-day period?					
No	41,503 (93.5%)	41,463 (93.8%)	40 (25.8%)	Reference	

Table 1 (continued)

Factor	Cohort <i>n</i> = 44,379 (%)	Ulcer present		OR (95% CI)	<i>p</i> value
		No <i>n</i> = 44,224 (%)	Yes <i>n</i> = 155 (%)		
Yes	2876 (6.5%)	2761 (6.2%)	115 (74.2%)	42.82 (29.82, 61.48)	<0.001
Intervention administered in the 30-day period?					
No	43,143 (97.2%)	43,129 (97.5%)	14 (9.0%)	Reference	
Yes	1236 (2.8%)	1095 (2.5%)	141 (91.0%)	383.96 (220.99, 667.11)	<0.001
Percutaneous coronary intervention					
No	43,302 (97.6%)	43,155 (97.6%)	147 (94.8%)	Reference	
Yes	1077 (2.4%)	1069 (2.4%)	8 (5.2%)	2.33 (1.14, 4.76)	0.02
History of deep vein thrombosis					
No	43,585 (98.2%)	43,437 (98.2%)	148 (95.5%)	Reference	
Yes	794 (1.8%)	787 (1.8%)	7 (4.5%)	2.79 (1.3, 5.98)	0.008
Therapeutic anticoagulation					
No	43,338 (97.7%)	43,191 (97.7%)	147 (94.8%)	Reference	
Yes	1041 (2.3%)	1033 (2.3%)	8 (5.2%)	2.41 (1.18, 4.93)	0.016
Oxygen dependent					
No	43,972 (99.1%)	43,821 (99.1%)	151 (97.4%)	Reference	
Yes	407 (0.9%)	403 (0.9%)	4 (2.6%)	3.25 (1.2, 8.81)	0.021
History of pulmonary embolus					
No	43,845 (98.8%)	43,697 (98.8%)	148 (95.5%)	Reference	
Yes	534 (1.2%)	527 (1.2%)	7 (4.5%)	4.19 (1.96, 8.99)	<0.001

SD standard deviation, *OR* odds ratio, *CI* confidence interval, *IQR* inter-quartile range

Table 2 Postoperative interventions for ulcer patients

	Incidence (%)	95% CI
Reoperations	13.7	(11.70%, 15.80%)
Readmissions	5.4	(4.59%, 6.28%)
Interventions	12.5	(10.74%, 14.52%)

CI confidence Interval

Table 3 Identification of MUs

Variable	Frequency	Percent
Marginal ulcer present?		
No	44,224	99.65
Yes	155	0.35
How was ulcer identified?		
All (reoperation, intervention, and readmission)	2	1.3
Both: readmission and intervention only	59	38.1
Both: reoperation and intervention only	3	1.9
Both: reoperation and readmission only	3	1.9
Intervention only	69	44.5
Readmission only	16	10.3
Reoperation only	3	1.9

dependent (OR 3.25), and/or have a pulmonary embolism (PE) (OR 4.19) as compared to patients without a MU.

After adjusting for BMI, operation length, and race, the most common preoperative conditions in MU patients were PTCA (OR 2.17), DVT (OR 1.72), and PE (OR 2.84). MU patients were more likely to have these complex preoperative complications than patients that did not develop MUs (Table 4).

Table 5 details complications that occurred within 30 days for patients with MU and those who did not have an ulcer. The most common postoperative complications were unplanned ICU admissions 597 (1.4%) followed by transfusions (*n* = 538, 1.2%), postoperative UTI (*n* = 211, 0.48%), and pneumonia (*n* = 193, 0.43%). The occurrence of ulcer was associated with unplanned ICU admissions (6.45% of patients with MU), transfusions (5.16%), postoperative UTI (3.87%), sepsis (1.94%), and MI (0.65%). Death occurred in 76 patients with no related cases to MUs.

Discussion

MU formation is a known complication after GB. Our results from the MBSAQIP database for 2015 show a low incidence of 0.35%. This reflects only the 30-day outcomes and most

Table 4 Adjusted association between presence of marginal outcome and selected cofactors

Factor	OR (95% CI)	<i>p</i> value
Dependent variable: marginal ulcer present (Yes vs. No)		
Operation length (min)	1.00 (1.00, 1.00)	0.10
BMI (kg/m ²)	1.02 (1.00, 1.04)	0.010
Race (reference = Black)		
Others	0.67 (0.09, 4.88)	0.69
Unknown	0.18 (0.04, 0.73)	0.017
White	0.77 (0.51, 1.14)	0.19
PTC (reference = No)	2.17 (1.04, 4.52)	0.038
History of DVT (reference = No)	1.72 (0.93, 3.18)	0.085
Oxygen dependent (reference = No)	2.21 (0.80, 6.06)	0.13
History of PE (reference = No)	2.84 (1.48, 5.45)	0.002

OR odds ratio, CI confidence interval, BMI body mass index, PTC percutaneous transluminal cardiac catheterization, DVT deep vein thrombosis, PE pulmonary embolus

of the published literature shows that the peak incidence of MU is after the 30-day postoperative period [8]. This analysis of the world's largest bariatric database confirms that MU formation is uncommon in the early postoperative period. Most occur after 30 days, but there may also be factors that are intrinsically linked to the perioperative period. In one of the few prospective trials with routine postoperative

endoscopy, Csendes et al. examined the natural history of MU by performing an endoscopy on all patients after GB [9]. They performed endoscopy on 411 patients submitted to GB (open $n = 360$, and laparoscopic $n = 81$) 1 month and 1 year after surgery. They found a relatively high rate with 4.1% of MU at 1 month in the open GB group and 12.3% in the laparoscopic GB group. Interestingly, almost one-third of these patients were asymptomatic, while those that were symptomatic complained mainly of either epigastric pain or emesis. The open GB patients had resection of the remnant stomach so this may confound generalization. The majority of the publications are retrospective, meaning that essentially only the symptomatic patients underwent a confirmatory endoscopy. This may skew the true incidence of MU by underestimating the number of asymptomatic patients.

Early versus late MU risk factors

The early risk factors demonstrated in this paper are very different from the common late risk factors. We found in this perioperative time period that the main conditions associated with MU are as follows: need for PTC (OR 2.17), history of DVT (OR 1.72) or PE (OR 2.84), and increased BMI (OR 1.02). We may surmise that the increased adjusted odds ratios for these variables lie partly in the need for aggressive anticoagulation in patients with

Table 5 Association between postoperative complications and MU

	Cohort <i>n</i> = 44,379(%)	Marginal ulcer present		<i>p</i> value
		No <i>n</i> = 44,224(%)	Yes <i>n</i> = 155(%)	
Acute renal failure present	69 (0.2)	69 (0.2)	0 (0)	0.62
Postop deep incisional SSI occurrences present	77 (0.2)	77 (0.2)	0 (0)	1.00
Myocardial infarction present	23 (0.1)	22 (0.1)	1 (0.7)	0.077
Unplanned admission ICU in 30 days present	597 (1.4)	587 (1.3)	10 (6.5)	<0.0001
Postop pneumonia present	193 (0.4)	192 (0.4)	1 (0.7)	0.49
Pulmonary embolism present	72 (0.2)	71 (0.2)	1 (0.7)	0.22
Unplanned intubation present	134 (0.3)	134 (0.3)	0 (0)	1.00
Death within 30 days present	76 (0.2)	76 (0.2)	0 (0)	1.00
Cardiac arrest CPR present	33 (0.1)	32 (0.1)	1 (0.7)	0.109
Transfusion intra/postop present	538 (1.2)	530 (1.2)	8 (5.2)	<0.001
Postop UTI (number of)				<0.001
0 times	44,168 (99.5)	44,019 (99.5)	149 (96.1)	
1–2 times	211 (0.5)	205 (0.5)	6 (3.9)	
Number of on ventilator > 48 h occurrences				1.00
0 times	86 (0.2)	86 (0.2)	0 (0)	
1–2 times	44,293 (99.8)	44,138 (99.8)	155 (100)	
Postop sepsis (number of)				0.006
0 times	44,272 (99.8)	44,120 (99.8)	152 (98.1)	
1–2 times	107 (0.2)	104 (0.2)	3 (1.9)	

SSI skin and soft tissue infection, ICU intensive care unit, CPR cardiopulmonary resuscitation, UTI urinary tract infection

these characteristics. All four of these ‘risk factors’ usually require a greater than usual chemoprophylaxis in dosing or length of treatment to prevent thrombotic events. Since the need for chemoprophylaxis will decrease further away from surgery, these risk factors will mitigate over time and the risk factors for late ulceration such as smoking and NSAID use will increase [10]. Marginal ulceration was more common in patients who had MI, unplanned admission to the ICU, transfusions, postoperative sepsis, and UTI. Unplanned admissions had the highest association in patients with MU with bleeding second at 24% of patients with MU, and roughly one-third were admitted to the intensive care unit or had a postoperative UTI. Bleeding can be a symptom of MU, but UTI is likely not. The most common method of diagnosis was endoscopy and only 3 patients of the 155 needed a reoperation. The exceptionally low rate of MU reported in the MBSAQIP database is likely due to the short time period studied as most MU occur after 4 weeks.

The nature of early versus late ulcers remains in question. There is an increase in MU with permanent suture or foreign bodies [11, 12]. There may also be local tissue ischemia or inflammation from the staples or suture used to create the gastrojejunal anastomosis. The ulcer may also be a reflection on some level of normal wound healing that becomes pathologic in some cases, leading to symptoms [12]. Sverdon et al. studied more than 20,000 patients and found that diabetes and a history of peptic ulcer disease increased the risk of MU after GB [13]. Coblijn et al. performed a systematic review in 2014 of nearly 17,000 patients. The follow-up period covered in these studies was much longer than the MBSAQIP, and ranged from 3 to 96 months. The incidence ranged from 0.6 to 25%. The risk factors they found included type of suture material, the position of the pouch, *Helicobacter pylori*, NSAID use, smoking, and demographic factors. Similar to our findings, they also found that cardiovascular disease was a risk factor. The additional risk factors elucidated by their review may indicate that late ulcer (> 30 days) is a different pathological mechanism [14]. Weiss et al. examined a statewide database and found the rate of MU to be 0.3%, 0.7%, and 1% at 1, 5, and 10 years, respectively [3]. They listed predictors of poor outcomes as male gender, age, smoking, alcohol, Medicare, Medi-Cal insurance, and Asian or Native American race. These are very different risk factors from what we found in our early outcomes. This is likely explained by the chief deficiency of the MBSAQIP database, specifically, the short follow-up. A recent study by Spaniolas et al. reviewed the New York state database of 35,000 patients undergoing GB and found that MU increases with time. The overall cumulative risk was 3.2% at 1 year, 4.7% at 2 years, 7.9% at 5 years, and 11.4% at 8 years. The main risk factor was smoking with an adjusted hazard ratio of 1.6; 95% CI 1.41, 1.73; $p < 0.001$. Their estimated 8-year

cumulative incidence of MU in tobacco users was 17.8% (95% CI 15.9%, 19.7%) [15].

The presence of *H. pylori* and its relationship to MU is also unclear. There are many studies that would indicate that *H. pylori* is not a risk factor for MU and treatment and eradication make no difference in incidence of MU. Rasmussen et al. studied this question and found time to onset was 4 months. They found a MU rate of 7% and when they specifically looked at *H. pylori*-positive patients, they found that those patients accounted for only 32% of the patients with ulceration. Sixty-eight percent of patients who were checked for *H. pylori* preoperatively were negative, but these patients still went on to develop MU, indicating that *H. pylori* infection may not contribute to MU [16]. More recently, Kelly et al. looked at the presence of *H. pylori* and anastomotic complications after GB. They had a 9.5% incidence of *H. pylori* infection in their series with 1.5% of patients with *H. pylori* developing MU, compared to 5.6% of patients that were *H. pylori* negative. Their follow-up and median time to MU was 362 days. They concluded that *H. pylori* may be protective of anastomotic complications in GB patients [17]. The MBSAQIP database does not capture *H. pylori* infection in bariatric patients, so no conclusions about this can be drawn from our paper.

Preventive strategies

Proton pump inhibitor (PPI) use following GB remains a common measure used to prevent MU formation. This practice is widely accepted, although the evidence for this practice is limited. Ying et al. published a meta-analysis regarding prophylactic PPI use to decrease the rate of MU [18]. This review demonstrated an incremental benefit of prophylactic PPI use. In patients treated with PPI, the average time to diagnosis was 8.2 months with a pooled incidence of 5%. When PPI use was compared to non-PPI use, the odds ratio of developing a MU was 0.5. Most cohort studies in this review established the diagnosis of MU by endoscopy in symptomatic patients. The length of PPI treatment was variable, ranging from 1 to 6 months with most studies using PPIs for the first 3 months after surgery. Garrido et al. designed a study where patients were treated with omeprazole 20 mg PO every day for 60 days after which all patients underwent diagnostic endoscopy. No patients were symptomatic at the time of the endoscopy; however, 7.6% were determined to have developed some type of MU. This calls into question the clinical significance of MU [19]. Moon et al. reported a single-center series. Patients were given prophylactic PPI treatment for the first 3 months postoperatively; however, the average time to ulcer formation was 15.2 months, with an incidence of 2.3%. This finding suggests that PPI use may not provide a long-term prophylactic benefit to MU formation [20]. Kalaiselvan et al. treated

patients for the first 2 years postoperatively with PPIs. They had an incidence of perforated MU of 0.82% with time to presentation of 13.5 months. Common factors were smoking and NSAID use [21]. The MBSAQIP database does not have the ability to follow patients this long, so the incidence of late ulcer in the U.S. is impossible to determine.

Treatment

The treatment of MU will depend on the presentation. Epigastric pain and dysphagia will usually respond to treatment with PPIs. PPIs will usually need to be taken for 3 months and ulcers may become refractory to medical management. Hemorrhage will often respond to PPIs and endoscopic modalities but in rare cases may require surgery with over sewing of the ulcer or revision of the gastrojejunal anastomosis. Perforation is a surgical emergency and will require laparoscopy or laparotomy to repair. This can be done with an omental patch or even a revision of the gastrojejunal anastomosis [21, 22]. Moon et al. found that 44% of their MUs presented requiring reoperation with 20.3% presenting with perforation [20].

There are several limitations to this study. The MBSAQIP database is subject to variations in data collection and reporting and may have incomplete or missing data. It only captures data from accredited bariatric Center of Excellence (COE) and therefore may not accurately depict the true incidence of complications in the whole population of bariatric patients. Also, individual surgeon outcomes are not obtainable from this database, and there is no way to account for the variable results of different COEs. The database also does not report symptoms such as emesis or abdominal pain so asymptomatic ulcers are probably missed. Additionally, the database does not allow for differentiation between obesity-related surgery and prior foregut surgery. The short time period for follow-up also is a limitation of the study, making it hard to determine the natural history of MU over a period > 30 days.

The strengths of this study are the size of this database. It spans two countries and collects data on all accredited centers. The data collection process is validated and less subject to bias. The size of our patient population allows some generalizability to the bariatric population at large.

Future studies

The conditions we found that had an increased adjusted odds ratio for MU were PTC (OR 2.17), history of DVT (OR 1.72) or PE (OR 2.84), and increased BMI (OR 1.02). It may be that these patients are “sicker” and therefore prone to ulceration, but these conditions are also associated with greater than usual chemoprophylaxis in dosing or length of treatment to prevent thrombotic events. While we cannot

draw a causal relationship between MU formation and anti-coagulation using the MBSAQIP database, this association is intriguing and warrants further study.

Conclusion

Using the MBSAQIP database, anastomotic ulcers seem to occur rarely in the first month. The large majority are diagnosed and treated endoscopically with minimal need for surgical intervention. The risk of anastomotic ulcer was increased with increased BMI, need for PTC, and history of DVT/PE.

Compliance with ethical standards

Disclosures Benjamin Clapp, Joshua Hahn, Christopher Doodoo, Angela Guerra, Elizabeth de la Rosa, and Alan Tyroch have no conflicts of interest or financial ties to disclose.

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