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Rapid excess weight loss following laparoscopic gastric bypass leads to increased risk of internal hernia

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Abstract
Background Internal hernia (IH) is one of the more acute and potentially devastating complications after laparoscopic gastric bypass (LGB). Currently, there is no way to predict which patients will develop IH. We propose that patients who undergo periods of rapid excess weight loss (EWL) following LGB are more likely to develop IH.
Methods A retrospective review of a prospectively collected laparoscopic gastric bypass database from our bariatric center was performed. Patient data between 2002 and 2009 was reviewed. Demographics, initial body mass index (BMI), detailed weight loss curves, and morbidity, specifically IH, were reviewed. Statistical analysis was performed. Logistic regression analysis was used to obtain an adjusted odds ratio for rapid weight loss and hernia development.
Results We reviewed all 934 LGB procedures performed. The average initial BMI was 49.1 kg/m^2 (range = 34–91 kg/m^2). EWL based on our current averages at 1, 3, 6, 9, and 12 months postoperatively were 20, 40, 60, 75, and 85%. We statistically defined rapid EWL as greater than the 90th percentile for weight loss. Rapid EWL was noted in 33.2% (310/934) of patients. Fifty-eight (6.2%) patients were identified with IH. Of these, 27(46.5%) had periods of rapid EWL (odds ratio [OR] = 1.83; 95% CI = 1.07, 3.02). Bivariate analysis of patient factors that led to rapid EWL identified initial BMI (49.3 vs. 46.6 kg/m^2) and rapid EWL as increasing the likelihood of developing IH ($p = 0.026$). A multivariate logistic model for IH identified only rapid EWL as a predictive factor. Locations of IH were the jejunojejunostomy (24), Pedersen's defect (23), adhesions (9), and colonic mesentery (1). There were five patients with combined JJ and Pederson's hernias.
Conclusion Outcomes from missed IH can be catastrophic. In our large, single-center series, we have found that patients who undergo periods of rapid EWL are at nearly twice the risk for development of IH as the rest of the gastric bypass population.

Keywords Internal hernia · Bariatrics · Hernia · Gastric bypass

The use of surgery as a treatment for morbid obesity has steadily increased over the past decade. Despite this, less than 1% of the eligible population currently is being treated surgically. With this number likely to climb, physicians in every specialty are quite likely to be called upon to treat gastric bypass patients in both routine and emergent settings.

Internal hernias can pose a life-threatening risk to the post-gastric bypass patient. Presentations can range from mild, colicky abdominal pain to complete bowel obstruction. With the incidence of internal hernia following Roux-en-Y gastric bypass ranging from 1 to 9%, the potential for intestinal strangulation in these patients should be considered and the possibility of internal hernia must be evaluated quickly [1–9].

Unfortunately, there are no good indices that predict which patients will develop an internal hernia after gastric bypass. We reviewed the gastric bypass patients who presented to our practice with an internal hernia so as to determine if there were any reliable factors heralding this

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complication. Specifically, we evaluated patient characteristics and weight loss curves to determine if there were factors that increased the incidence of internal hernia in our gastric bypass patients.

Methods

A retrospective review of a prospectively collected laparoscopic gastric bypass database from our bariatric center was performed. Patient data between 2002 and 2009 was reviewed upon Institutional Review Committee approval. All procedures during the time period were performed laparoscopically by a single surgeon in either an antecolic or a retrocolic manner with closure of the mesenteric defect at the jejunojejunostomy. Patient demographics, in addition to initial body mass index (BMI), detailed weight loss curves, comorbidities, and the presence of internal hernia (IH) were evaluated. In all cases of IH confirmed by operation, the preoperative diagnosis of IH was made using computed tomography, contrasted small bowel series, or high clinical suspicion without confirmatory studies. At the time of surgery, IH was diagnosed by finding small-bowel herniation through a surgically created defect or the presence of the surgically created defect alone. The details of the individual IH location were recorded as well. Statistical analysis of the pertinent patient data was performed and an odds ratio for rapid weight loss was calculated. Continuous data were evaluated using Student's t test, while categorical data were assessed using Pearson's χ^2 test. Logistic regression analysis was conducted to estimate the independent effect of rapid weight loss on internal hernia development. All data analyses were completed using SAS version 9.1 (SAS Institute, Cary, NC).

A standard five-port laparoscopic Roux-en-Y-divided gastric bypass was performed in each case. In all patients a 15-30-ml gastric pouch with stapled division of the remaining stomach was created. The jejunojejunostomy was performed by creating a 50-cm biliopancreatic limb with a 150-cm Roux limb. The gastric anastomosis was performed using a 25-mm ILS stapler (Ethicon Endo-Surgery, Cincinnati, OH). Antecolic procedures were performed by bringing the Roux limb through a divided greater omentum. The retrocolic anastomosis was performed by passing the Roux limb through a transverse colon mesenteric defect. Potential hernia sites in both procedures were closed with absorbable braided sutures.

Results

A total of 934 patients underwent a laparoscopically divided gastric bypass from 2002 to 2009. Demographics for this patient population are given in Table 1. Average initial BMI was 49.1 kg/m^2 (range = 34-91 kg/m^2). The first 130 (14%) cases were reconstructed in a retrocolic manner; all subsequent cases were done in an antecolic manner. There was no statistical difference in the rate of internal hernias between these two groups (4.6% vs. 6.2%, $p = 0.077$). Overall perioperative morbidity was 11% ($n = 104$) for all patients (Table 2), although the actual rate is somewhat lower because several individual patients had more than one of the noted findings. Internal hernia occurred in 6.2% ($n = 58$) of the patients. Of those who developed an IH, 81% (47/58) were able to be repaired laparoscopically. The majority of IHs was through the mesentery of the

Table 1 Demographics for 934 laparoscopically divided gastric bypass patients

	Overall	No hernia	Internal hernia
Age	45.4	46.1	44.9
Race			
White	934	697	47
Nonwhite	127	51	11
Sex			
Male	174	139	12
Female	760	609	46
Initial BMI (kg/m^2)	49.1	49.2	46.2

Also included is the breakdown between those who had internal hernia and those who did not

Table 2 Complications following gastric bypass

Complication	Number of occurrences
Internal hernia	58
Cholecystitis	9
Dehydration	8
Bowel obstruction	5
Gastrogastric fistula	5
Anastomotic leak	5
Anastomotic stenosis	3
Ventral hernia	3
Postoperative bleeding	3
GI bleeding	2
Pulmonary embolus	1
Hypokalemia	1
Infection	1
Pleural effusion	1
Pancreatitis	1
Mesenteric vein thrombosis	1
DVT/PE	1

Included are those complications that required hospitalization or additional intervention

Table 3 Internal hernia location by total occurrence

	Occurrences	Percentage (%)
Jejunojejunostomy	23	39
Petersen's defect	22	38
Adhesions	8	14
Colon mesentery	5	8.6
Combined defect	5	

Combined hernias are described as multiple internal defects. The more significant defect was included in the occurrence numbers

Table 4 Expected postoperative weight loss schedule based on our institutional weight loss averages

Postoperative visit (months)	Expected excess weight loss (%)
1	20
3	40
6	60
9	75
12	85

jejunojejunostomy (Table 3). All hernias were repaired with permanent braided suture at the time of exploration.

Expected weight loss at specific postoperative time periods for these patients are given in Table 4. For the purposes of our analysis, rapid excess weight loss is defined as loss of greater than the 90th percentile of expected weight loss between any two time periods in the first postoperative year. First-year weight loss curves were chosen because the majority of weight loss occurs within 12 months of surgery. Any of the defined periods that met our definition qualified a patient as having a period of rapid excess weight loss. Weight loss curves were reviewed for all patients. Fifty-eight (6.2%) patients were discovered to have developed an IH. Of these, 27 (46.5%) were noted to have had periods of rapid excess weight loss consistent with the previous definition. Statistical evaluation for odds ratio (OR) showed that patients who developed an IH were 1.83 times more likely to have undergone periods of rapid excess weight loss (OR = 1.83; 95% CI = 1.07,3.02).

The weight loss curves for the remaining 876 patients who did not develop an IH were also examined. Of these, 310 patients (37%) had periods of rapid excess weight loss consistent with the above definition. There were no baseline factors favoring hernia formation. Age, BMI, race, and surgical technique (ante- versus retrocolic) were not found to be predictive of IH formation.

Since rapid excess weight loss was noted to be a risk factor for IH formation, separate analysis of patient data was done to determine if there were any patient characteristics predictive of rapid weight loss. On bivariate analysis, one factor that that favored periods of rapid excess weight loss was a lower initial BMI (46.6 vs. 49.3 kg/m^2, $p = 0.024$). On multivariate analysis of the three factors initial BMI, antecolic vs. retrocolic, and EWL, only EWL was noted as a significant predictor of IH with a risk ratio of 1.83 (95% CI = 1.07, 3.12).

Discussion

Gastric bypass patients are at risk for multiple complications following laparoscopic gastric bypass (LGB). Although most of the complications are seemingly minor (anemia, nutritional deficits, stricture), one of the potentially more devastating complications is internal hernia (IH). Based on the anatomic defects created at the time of operation, patients are at lifetime risk for developing this complication as long as a defect exists. However, up to the present report, there has been no reliable way to predict which patient is more likely to develop an IH. In the present study, patients who developed an IH had time periods during which they lost significantly more weight in a shorter period of time than the group average. We chose to describe this amount with the statistically reproducible cutoff of the 90th percentile. Patients that exceeded the 90th percentile in terms of weight loss for a defined period of time were considered to have experienced rapid EWL. We then evaluated interval weight change at standard postoperative follow-up appointments. Therefore, if patients were ahead of, or behind, the average weight loss curves, large changes in weight were still able to be identified. This pattern of significant EWL was consistent across a majority of patients identified as having an IH.

In the current study, it is possible that the true incidence of IH has been underestimated. An incidence of 6% addresses only those patients who became symptomatic. It is likely that the existence of asymptomatic hernia is even higher than this. This is a major shortcoming for any study attempting to determine the risk for IH. Another possible limitation is the lack of long-term patient follow-up. In terms of time to presentation, patients with IH in this series on average presented 15.6 months after the initial operation. Our follow-up rate at 1 year was 97% and at 2 years exceeded 88%, both of which are consistent with the current literature.

Presentation of IH ranges from minor abdominal pain requiring elective repair to profound peritonitis due to massive segments of ischemic/necrotic bowel requiring resection. The presentation of an IH may be considerably more benign than the underlying causative bowel pathology. Due to the increasing number of patients undergoing bariatric procedures, a large number of these patients are likely to be cared for by general surgeons as well as by

individuals who may not be familiar with the LGB operation. This latter group significantly increases the potential for missing serious IH complications because of a less acute presentation and presumed relatively minor symptoms. Accordingly, there is a need to identify potential indicators and patient factors that make patients more likely to develop IH. The present study identifies a risk factor that is relatively easy to assess and is especially helpful when a diagnosis is in question. Rapid excess weight loss can lead to laparoscopic intervention in lieu of computed tomography in cases where patients have symptoms that are suggestive of IH.

No definite reason has been identified to explain the increase in IH in patients who lose their excess weight quickly. A suggested mechanism is that mesenteric fat is lost quickly (as is excess abdominal wall fat) and does not allow adequate time for closure of the potential hernia space. Although all potential hernia defects were closed at the time of the initial surgery with absorbable braided suture to prevent possible hernia, IH still occurred. Some authors believe that no specific closure is needed while others argue that a permanent suture should be used [3, 7, 10]. On detailed analysis, no final word has been conclusively written about the dilemma.

Periods of rapid excess weight loss are easy to identify and follow. Based on our data, those periods of rapid excess weight loss are also significant risk factors for developing an internal hernia. It is a risk factor that can easily be ascertained and can be a helpful guide in the decision-making process to correct IH complications before they lead to strangulation and ischemia. It appears that the risk is not a result of continuous rapid excess weight loss; it is the mere exposure to a time period of rapid weight loss that increases hernia risk. All patients who have undergone LGB should be followed closely to identify periods of rapid excess weight loss. These patients should be informed that that they may be at higher risk for IH and should be able to communicate this to any future treating surgeons.

Conclusion

The goal of the present study was to find whether periods of rapid weight loss after laparoscopic gastric bypass might be a predictive factor in patients who later developed an internal hernia. The incidence of subsequent internal hernias following laparoscopic gastric bypass at our institution was 6.2% (58/934), which is consistent with what has been reported. A statistically significant number of our postoperative patients who developed internal hernia experienced periods of rapid postoperative weight loss. Forty-seven percent (47%) of those patients who had internal hernias had at least one period of weight loss consistent with our definition of excess weight loss within their first postoperative year. In those patients who did not develop an internal hernia, defined periods of rapid weight loss were much less common.

Based on this data, rapid weight loss appears to be a reliable risk factor for developing an internal hernia after gastric bypass surgery. Patients with periods of rapid weight loss are at increased risk for internal hernia and symptoms that are concerning for internal hernia should elicit greater concern for the presence of these defects.

Disclosures William Cobb receives educational support, is a consultant for, and is on the speaker's bureau for WL Gore. He is on the speaker's bureau at Ethicon Inc. and receives educational support from and is a consultant for Ethicon EndoSurgery. He is also on the speaker's bureau and is a consultant for Covidien. John Scott is an advisor for WL Gore and receives grant support from Ethicon EndoSurgery. Alfredo Carbonell is a speaker and consultant for and receives grant support from WL Gore, is a consultant and advisory board member for Ethicon Inc., receives grant support from Ethicon EndoSurgery, and is a consultant for Kensey Nash. Eric Bour receives fellowship funding from and is a speaker for Ethicon Endosurgery and is a speaker for WL Gore. Christopher Schneider and Katie Myers have no conflicts of interest or financial ties to disclose.

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