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CT Scan Reliability in Detecting Internal Hernia after Gastric Bypass

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ABSTRACT

Background and Objectives: Internal hernia (IH) after gastric bypass can be a life-threatening complication. Obstruction presents acutely or as chronic relapses, with symptoms of abdominal pain, nausea, and vomiting. Early detection and exploration of IH as the cause of small bowel obstruction (SBO) is critical in this surgical emergency and can reduce morbidity and mortality. We conducted a retrospective review of laparoscopic Roux-en-Y bypass (LRYGB) records to determine the specificity and sensitivity of computed tomography (CT) in identifying postoperative IH.

Methods: Records of 550 patients who underwent antecolic antegastric laparoscopic Roux-en-Y gastric bypass (LRYGB) surgery over a 5-year period (2010–2014) were retrospectively reviewed for complications. Our study population comprised patients who returned with signs and symptoms of obstruction who underwent CT imaging followed by laparoscopic exploration.

Results: Thirty-four patients were found to have obstruction on CT scan at ≥6 weeks after LRYGB. Six (17.7%) were found to have IH by preoperative CT imaging before laparoscopic exploration. Of the 6 patients identified to have IH before exploration, 4 (28%) had consistent findings at operation, yielding a sensitivity of 28.6% and specificity of 90.0%. Operative findings identified other causes of SBO: adhesions (n = 17), IH (n = 14), jejunojejunostomy stenosis (n = 2), and phytobezoar (n = 1).

Conclusions: IH after LRYGB is difficult to detect. Our study found CT to have a low sensitivity but a high specificity in detecting IH. Therefore, laparoscopic exploration continues to be the best diagnostic and therapeutic intervention for this complication.

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INTRODUCTION

Obesity is a rapidly rising health concern in the United States. From 2000 to 2010, the prevalence of obese individuals increased from 3.9% to 6.6% (an increase of 70%).[1] Along with obesity, there has been a corresponding increase in obesity-related comorbidities, such as diabetes and obstructive sleep apnea.[2] Bariatric surgery—in particular, laparoscopic Roux-en-Y gastric bypass (LRYGB)—is an effective method of treating obesity and its associated complications.

Despite its benefits of weight loss and the resolution of comorbidities, bariatric surgery has risks as well. One of the most feared complications of the LRYGB is bowel obstruction, which carries a high risk of morbidity and mortality if left surgically untreated.[3] Small bowel obstruction (SBO) after LRYGB occurs in 1.5–5% of patients nationwide and can be caused by jejunojejunostomy stenosis, adhesions, incarcerated ventral hernia, IH, bezoar, or intussusception.[3–7] Adhesions and IHs are the most common causes of SBO after LRYGB. According to findings by Patel et al[3] and Koppman et al,[6] IH consists of 14.3% to 42% of all bowel obstructions after LRYGB. Although IH can be a major cause of SBO, the overall incidence of IH formation after LRYGB is between 0.2% and 9%.[3] Because of the low incidence, there is even disagreement among authors as to whether routine closure of mesenteric defects affects the rate of IH formation and complication.[4,5]

Morbidity and mortality associated with symptomatic IH can be reduced with early recognition and surgical intervention.[3,8,9] Delays in diagnosis can lead to bowel ischemia, perforation, and sepsis, resulting in mortality rates reaching 1–2%.[10] The clinical presentation of obstruction in the acute setting usually involves symptoms such as abdominal pain, nausea, and vomiting. Because of the nonspecific nature of these symptoms, it is important to use all available data in determining an etiology for obstruction, and diagnosis ultimately relies heavily on radiographic findings.

Imaging studies can be helpful in narrowing the differential and can identify a particular etiology. A commonly used form of imaging for detecting SBO is the multidetector row CT, which can detect SBO and has the potential to identify IH as the cause.[11] The intent of our study was to evaluate the sensitivity and specificity of CT imaging in diagnosing IH within our own population of bariatric patients with surgically confirmed IH.

METHODS

Subject Selection

This was a retrospective review of a prospectively maintained database to determine how reliably preoperative CT imaging detects IH. After approval from our Institutional Review Board, we retrospectively reviewed the records of patients who underwent antecolic antegastric LRYGB by one surgeon at a single institution from January 2010 through April 2015. The study population consisted of patients who presented to the emergency department with signs and symptoms of obstruction after LRYGB. Inclusion criteria were patients ≥18 years of age who had had an LRYGB and patients who underwent an abdominal CT followed by surgical exploration. Patients were excluded if they did not have a CT scan, if their surgery was a revision of previous bariatric surgery, if they had open RYGB, or if there was no surgical intervention to confirm or exclude the radiographic findings.

Data Collection

Patient data from 550 subjects were collected from a single hospital's electronic medical records and a prospectively maintained database. Patient characteristics included age, gender, body mass index (BMI) at time of original surgery, and total weight loss from time of original surgery to presentation with signs of complication. CT scan reports were reviewed, and the diagnosis and etiology were recorded. From each patient's operative report, surgically confirmed diagnosis and etiology were also recorded. In addition, if IH was present, the location was recorded. The CT scans had been read by different radiologists, including some reading from distant locations during nighttime hours.

Surgical Technique

The LRYGB procedure was performed in an antecolic, antegastric fashion with a hand-sewn gastrojejunal anastomosis, and the jejunojejunostomy anastomosis was stapled. Mesenteric defects were not closed routinely. The procedure was performed by a single surgeon and was performed identically in all patients. Patients returning with acute obstructive symptoms underwent diagnostic laparoscopy or laparotomy. Any IH identified at that time was reduced and the defect closed primarily with permanent sutures.

Statistical Analysis

Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated from our categorical data by GraphPad Scientific Software and a 2-way contingency table, with 95% confidence intervals determined using the efficient-score method. The presence or absence of IH was validated by operative findings, whereas CT detection represented our test variable. A 2-tailed *P*-value was calculated from Fisher's exact test. Statistical significance was defined as $P \leq .05$.

RESULTS

Patient Demographics

Of the 550 LRYGB patients, 34 patients (6.2%) presented to the emergency department with symptoms of bowel obstruction. All 34 patients underwent CT imaging followed by surgery. Our population consisted of 7 men and 27 women of age ranging from 19 to 59 years, with an average BMI of 47.3 at time of presentation and an average weight loss between the time of their original surgery and presentation with complications of 36.2 kg (**Table 1**).

Etiology of Small Bowel Obstruction

Four separate etiologies were identified as causes of SBO: adhesions (n = 17), IH (n = 14), jejunojejunostomy stenosis (n = 2), and phytobezoar (n = 1). Most SBOs were caused by adhesions (50%) followed by IH (41.2%).

IH Detection and Type

IH was found in 6 (17.7%) patients by CT imaging and in 14 (41.2%) by operative exploration. Of the 6 IHs identified by CT imaging, 4 (28%) were confirmed during surgical exploration. In the 14 cases of surgically confirmed IH, operative reports identified the following types of IH: 11 (78.6%) mesojejunal, 3 (21.4%) Petersen's, and no transmesocolic.

Table 1. Descriptive Statistics of Patients in the Study				
Variables	Mean	SD	Min	Max
Age at first operation	42.5	11.1	19	59
Initial BMI	47.3	7.9	36.4	62.9
Initial weight (kg)	130.6	27.4	89.8	201.8
Weight at second operation	96.6	31.2	67.0	181.4
Weight loss (kg)	36.2	18.2	−2.7	86.2
Time from initial surgery to re-exploration (days)	538.1	475.9	6	1492
Gender (N, %):				
Male	7	20.6		
Female	27	79.4		

N = 34. SD, standard deviation; Min, minimum; Max, maximum.

Statistical Analysis

CT detection and operative findings of IH are displayed in a 2-way contingency table (**Table 2**). The operative finding of IH is considered to be absolute confirmation, whereas CT detection represents our tested outcome. CT imaging detected 6 IH, 4 of which were true positives. Of the 28 patients found to not have IH by CT, 18 were true negatives. As a result, for the use of CT imaging in the diagnosis of IH, we found the sensitivity to be 28.6% (CI: 9.58–58.0%) and specificity to be 90.0% (CI: 66.87–98.25%). Fisher's exact test yielded a 2-tailed $P = 0.2022$. With the prevalence of IH in our group of 34 patients being 41.18%, the NPV was calculated to be 64.3% (CI: 44.11–80.70%) and the PPV to be 66.7% (CI: 24.11–94.00%).

DISCUSSION

RYGB can be performed as open or laparoscopic surgery, although most cases are now performed laparoscopically.

Table 2.
Two-Way Contingency Table Depicting Presence or Absence of IH by CT Findings as the Tested Outcome Versus the Actual Presence or Absence of IH Found at the Time of Surgery

	Intraoperative finding of IH		
	Absent	Present	P-value
Test Outcome: CT finding of IH			
Absent	18	10	0.2022
Present	2	4	

A comparison by Brolin[12] of data in multiple prospective studies showed LRYGB to be associated with reduced cost, shorter hospital stay, decreased infection rate, and an overall reduction in morbidity and mortality. The laparoscopic approach is also believed to result in fewer adhesions, which leads to less bowel fixation and more susceptibility to IH.[6] Compared with the retrocolic retrogastric approach, the antecolic antegastric approach minimizes the number of mesenteric defects created and consequently is less commonly associated with IH formation,[7,13,14] although some still occur. IH is reported to occur at 3 potential locations after LRYGB (**Figure 1**): the transverse mesocolon (in retrocolic bypasses), Petersen's space (Petersen's hernia), and the jejunojejunostomy mesenteric defect (mesojejunal hernia).

Detection of IH by CT imaging was found in our study to have a low sensitivity (28.6%) and a high specificity (90.0%). The PPV and NPV were found to be relatively low at 66.7% and 64.3% respectively. We had mixed agreement with the surgical literature which reports wide ranges of sensitivity and specificity of CT scans regarding IHs. Iannuccilli et al[10] and Lockhart et al[15] have shown similar high specificity between 70 and 100%, but sensitivity has been reported above 60% in their studies.

Our patients all underwent LRYGB with the antecolic antegastric technique. Within our population of 550 patients, 14 (2.5%) developed IH. Of the 14 IHs identified during surgical exploration, 11 (78.6%) were mesojejunal, 3 (21.4%) were Petersen's, and none was retrocolic (all cases were antecolic). The frequency of each hernia type we observed follows a more variable trend reported in other studies. Patel et al[3] had a 3.1% IH rate with 71% of

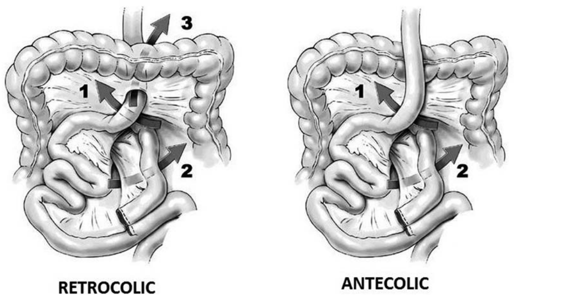

Figure 1. Arrows 1–3 indicate potential spaces for hernia formation: (1) Petersen's space, between the Roux limb mesentery and the transverse mesocolon; (2) the mesenteric opening at the biliopancreatic limb; and (3) the opening through the transverse mesentery when the bypass is in retrocolic fashion. (Image from Kim Y, Crookes PF. Complications of bariatric surgery. In: Essentials and Controversies in Bariatric Surgery. Huang, C-K, ed. Available at: https://www.intechopen.com/books/essentials-and-controversies-in-bariatric-surgery/complications-of-bariatric-surgery. © 2014 Kim Y, Crookes PF. Published under CC BY 3.0 license. Available from: http://dx.doi.org/10.5772/58920. Accessed February 16, 2016).

those in the transmesocolic space; Lockhart et al[15] had a 3.7% IH rate, with 72% of those found in the Petersen's space; and Kawkabini Marchini et al[16] had a 9.7% IH rate, with 44% being mesojejunal and 29% Petersen's.[4,15,16]

The current literature disagrees on the frequencies of each of these IH types, as the cause of SBO, with IH ranging from 1.6% to 42% of the time.[3,5,17] This observation is likely caused by a variety of factors, including the antecolic versus retrocolic approach, the experience of each surgeon, the patient populations involved, whether mesenteric defects were closed, and the amount of weight loss. Within our population, we found the most common cause of SBO to be adhesions in 50% (n = 17) followed closely by IH in 41.2% (n = 14), with other studies showing similar results.[5] We found a rate of IH formation after antecolic antegastric LRYGB of 2.5%, which falls within previously reported ranges of 0.2–5% for the antecolic antegastric approach.[3,6]

The literature addressing detection of IH after bariatric surgery by CT imaging focuses on specific signs. There are two commonly cited studies that consisted of small populations from single institutions. Lockhart and colleagues[15] analyzed 7 specific signs of IH on CT imaging. Three radiologists reviewed CT imaging of 18 patients with IH and 18 without, focusing on swirled appearance of mesenteric fat or vessels, mushroom shape of hernia, tubular distal mesenteric fat surrounded by bowel loops, SBO, clustered loops of small bowel, small bowel other than duodenum posterior to the superior mesenteric artery, and right-side location of the distal jejunal anastomosis. They found the mesenteric swirl sign to be the best single predictor of hernia with sensitivities of 61%, 78%, and 83%, and specificities of 94%, 89%, and 67% for the 3 reviewers, respectively. This finding agreed with another group, Iannuccilli and colleagues,[10] who looked at 8 CT signs of IH which showed the mesenteric swirl sign to be most predictive of IH. They also reported the presence of both SBO and engorged lymph nodes to be 100% specific to IH. Although CT did identify SBO in 100% of our study population, we did not find CT to be nearly as sensitive (28.6%) at detecting IH. Our findings agreed with the literature, however, in having a high specificity (90.0%). Understandably, CT is likely to have a lower sensitivity than surgical exploration, which allows for direct visualization of the underlying pathology.

There are limitations to the applicability of this study, including its retrospective nature. Most important, the significance of observations and conclusions described are limited by a small sample size (N = 34) and a $P = 0.2022$ that did not reach statistical significance. This reflects the nature of our and other similar IH studies comparing reliability of CT scans where sample sizes are small due to the infrequency of this complication.

It is important to note that our imaging was reviewed by several separate radiologists, with some imaging being interpreted by radiologists outside our institution. This is reflective of the current state of radiology outside of academic institutions. With the advent of "night services" offered remotely via the Internet, there is increased variability in the quality of CT scanners as well as the specific radiologist's familiarity with the bariatric patient's anatomy. In addition, most of our radiologists' interpretations did not list specific signs of IH, but simply the presumed diagnosis of SBO and its etiology. Therefore, we cannot reliably determine whether there was uniformity in the diagnostic criteria used among our radiologists when assessing for IH. This inconsistency may have contributed to the reduced sensitivity observed from our data compared with other existing literature.

CONCLUSION

IH represents an important complication of gastric bypass surgery which requires a high index of suspicion to identify and promptly treat. Because of the low sensitivity of CT in screening for IH, surgical exploration is still the best diagnostic and therapeutic intervention for this complication. Nevertheless, CT imaging should continue to be recommended as part of the preoperative workup of obstructed bypass recipients, because it can detect other potential pathologies and, when positive, is highly specific for IH.

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