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CLINICAL RESEARCH

Radiological Findings in Symptomatic Internal Hernias After Laparoscopic Gastric Bypass

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Abstract
Background Internal hernias (IHs) can complicate laparoscopic Roux-en-Y gastric bypass (LRYGB). A number of radiological investigations can be used in the diagnosis. These include plain X-rays, upper gastrointestinal (UGI) series, ultrasound, and computed tomography (CT) scanning. We present radiological findings in our series of 58 symptomatic internal hernias based on our 6-year experience (2000-2006) of 2,572 LRYGB patients.
Methods A retrospective chart review was performed of all patients undergoing LRYGB who developed symptomatic internal hernia requiring operative intervention between January 1, 2000 and September 15, 2006. Types of radiological tests performed and their results were recorded.
Results Fifty-eight symptomatic internal hernias were recorded, of which 56/58 (97%) underwent radiological investigation; 2/58 went directly to surgery. Of the 56 patients who underwent diagnostic imaging, 41 plain abdominal X-rays, 37 CT scans, 26 UGI series, and eight ultrasound scans were performed. Sixty-five percent of UGI series and 92% of CT scans had positive features diagnostic of internal hernia. Performing both CT and UGI series successfully diagnosed IH in 100% of cases. Subgroup analysis did not reveal any association between positive result of imaging test and type of internal hernia.
Conclusion CT scanning is the single most effective radiological investigation for diagnosing internal hernias post-LRYGB. In non-diagnostic cases, the addition of an upper GI series increases the diagnostic rate to 100%.

Keywords Internal hernia · Radiology · X-ray · CT scan

Background

Obesity is increasingly recognized as a major threat to human health in the developed world. Increased weight causes increased morbidity and mortality due to its association with cardiovascular disease, diabetes, and certain cancers [1]. Two large, landmark studies have recently confirmed that bariatric surgery, especially Roux-en-Y gastric bypass, results in long-term weight loss and a significant long-term decrease in mortality in severely obese patients [1,2].

The popularity of the laparoscopic gastric bypass approach continues to increase primarily because it has fewer perioperative complications, a shorter hospital stay, and a more rapid recovery time than open surgery [3–5]. Some researchers have found that IHs occur more frequently after laparoscopic procedures than after open operations [3,5–8], possibly because the laparoscopic approach induces fewer postoperative adhesions [9–11] and the resulting decreased fixation of bowel loops to the abdominal wall increases the risk of entrapment of the loops across hernia defects created at laparoscopic Roux-en-Y gastric bypass (LRYGB). The common sites of internal herniation after LRYGB are through the transverse mesocolic defect (if a retrocolic Roux limb is used), Peterson's space (i.e., the

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space between the Roux limb mesentery and the transverse mesocolon), and the distal anastomosis mesenteric defect (enteroenterostomy). The occurrence of IHs after LRYGB is a source of concern because they can have serious sequelae, including acute SBO with gangrene and subsequent bowel perforation [9].

Clinically, internal hernias can be asymptomatic or cause significant discomfort ranging from constant vague epigastric pain to intermittent colicky periumbilical pain. Patients with symptomatic internal hernias often present acutely to the emergency department with clinical features suggestive of bowel obstruction—intolerance of per oral intake, nausea, vomiting, and abdominal pain. Symptom severity relates to the duration and reducibility of the hernia and the presence or absence of incarceration and strangulation. The differential diagnosis includes anastomotic stricture, Roux limb constriction (in cases of retrocolic Roux limb placement), adhesions, cholelithiasis, and marginal ulceration. In order to narrow the diagnosis, diagnostic imaging techniques may be used. These include plain abdominal X-ray, ultrasound, upper gastrointestinal (UGI) series, and computed tomography (CT) scan. Because of the propensity of these hernias to spontaneously reduce, patients are best imaged when they are symptomatic [12]. Having said that, delayed treatment can have catastrophic consequences and thus patients with worrisome findings on presentation should be considered for immediate surgical exploration without radiological work-up.

The objective of this study is to determine (1) which is the most accurate imaging modality to diagnose internal hernias post-LRYGB and (2) what are the radiological signs suggestive of internal herniation.

Materials and Methods

A retrospective chart review was performed of all patients (2,578) undergoing LRYGB who developed symptomatic internal hernia requiring operative intervention between January 1, 2000 and September 15, 2006. During the postoperative observation period, 58 patients presented with abdominal pain, nausea, vomiting, or a combination of these symptoms and were found at relaparoscopy to have an IH; thus, the overall IH rate in the series was 2.2%. A retrospective review of the medical records of the 58 patients with an IH was conducted and the following information noted: the types of radiological tests performed on presentation and their results were recorded; all radiology reports were accessed using our hospital's electronic radiology results database (Stentor) and the final verified radiologist report used for this study. It should be noted on the radiology request forms for CT scanning and upper GI study, a clinical comment was made detailing the need to exclude IH, bowel obstruction. A second analysis was performed to see if any clear radiological patterns emerged suggesting (1) presence of internal herniation and (2) location of internal herniation.

Patients underwent upper GI series with orally administered water-soluble contrast medium (diatrizoate meglumine and sodium [Gastroview]; Mallinckrodt Medical, St Louis, MO). Patients underwent evaluation with Helical CT scanner (Philips Brilliance 16P, Philips, Cleveland, Ohio). Section thickness was 5 mm, and scans were obtained with contrast medium administered intravenously, patients received 100 mL of 64% iodinated non-ionic contrast medium (ioversol [Optiray 300]; Mallinckrodt Medical) administered at a rate of 2–3 mL/s with a power injector (OptiVantage DH, Liebel-Flarsheim, Mallinckrodt Medical). Oral contrast medium was also used routinely.

Results

Fifty-eight symptomatic internal hernias were recorded, of which 56/58 (97%) underwent radiological investigation and 2/58 went directly to surgery. Figure 1 demonstrates the types of imaging tests performed in the cohort. A number of patients underwent more than one imaging test. Table 1 summarizes the results of the imaging tests performed. For the purposes of our analysis, a positive finding of an internal hernia is defined as any abnormal radiological finding suggestive of intestinal obstruction since direct identification of an internal hernia defect itself is difficult.

None of the eight abdominal ultrasound scans diagnosed internal hernias. The main indication for ordering abdominal sonogram was to exclude acute gallbladder pathology. 34 out of 37 (92%) CT scans (with oral contrast) performed were reported positive for internal hernia (Fig. 2 shows an example). The CT scan reports were further analyzed and their findings summarized. Four recurring findings were identified: (1) dilated small bowel, (2) distended gastric remnant, (3) excess small bowel loops in the lesser sac, and (4) thick-walled fluid filled small bowel. Of the three internal hernias (two transverse mesocolic and one enteroenterostomy) that were negative on CT, two underwent upper GI series which had positive findings suggestive of internal hernia; the third patient underwent laparoscopy as the CT scan although negative for internal hernia demonstrated a thickened appendix suggestive of appendicitis. At laparoscopy, an enteroenterostomy internal hernia was found. Seventeen out of 26 (65%) of upper GI contrast series were reported positive for internal hernia (Figure 3 shows an example). The upper GI radiology reports identified four recurring findings suggestive of internal hernia: (1) dilated fluid filled small bowel loops, (2) redundant Roux limb in lesser sac, (3) preponderance of

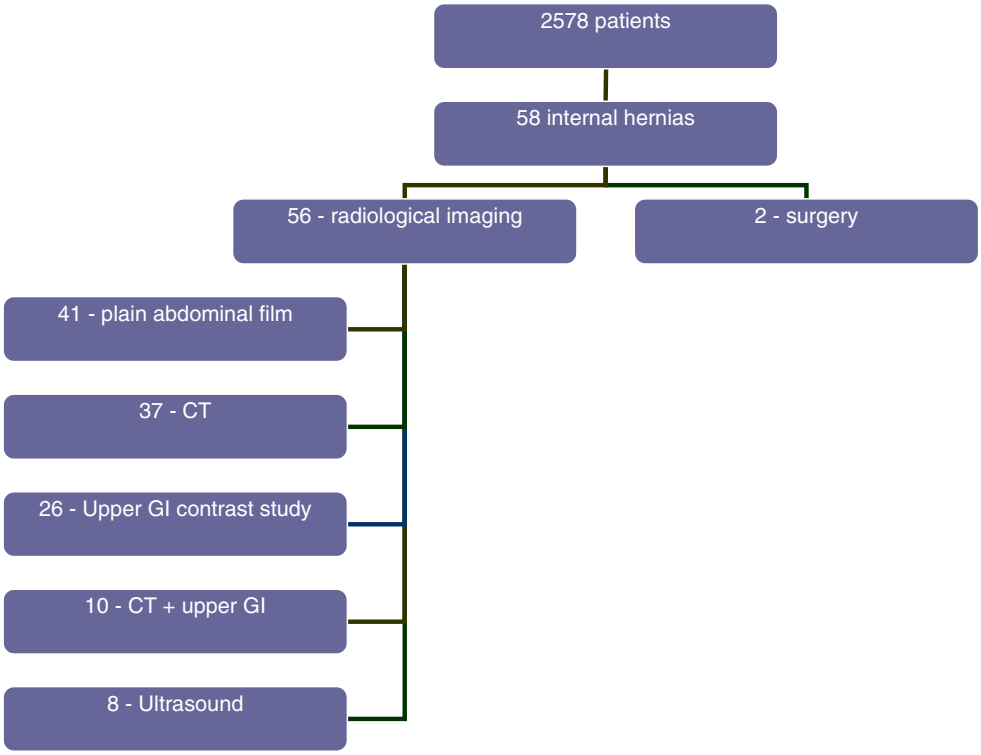

Fig. 1 Diagnostic imaging tests performed in 58 symptomatic internal hernias

bowel loops in the left upper quadrant, and (4) slow emptying of contrast with prolonged transit times, especially on delayed films. Of the nine upper GI series that were reported negative, CT scans were performed in four of these and were reported positive for internal hernia. The results of this study also demonstrate that the ten patients who underwent both CT and Upper GI series had correctly diagnosed internal hernia in all cases. In our secondary analysis, we could not find any evidence to suggest an association between particular radiographic findings and location of internal hernia.

Discussion

Internal hernias are a known complication after LRYGB with an incidence of around 2% in the present series which is in keeping with a recent review of 26 studies [4]. It is important to identify them so that timely treatment may be instituted. Patients often present with non-specific symptoms with a diverse differential diagnosis. Hence it is useful to know which diagnostic imaging test offers the most likelihood of correctly identifying IH. The results of this study indicate that CT scanning with IV and PO contrast correctly identified IH in 92% of cases. In equivocal cases, the addition of UGI study increases the diagnostic rate to 100%. Regardless of these findings, it is important not to

Table 1 Type of diagnostic imaging modality performed and results

Radiological test performed	No.	Positive finding suggestive of internal hernia (%)
Abdominal X-ray	41	19 (46)
CT	37	34 (92)
Upper GI contrast	26	17 (65)
CT + upper GI contrast	10	10 (100)
Ultrasound abdomen	8	0 (0)

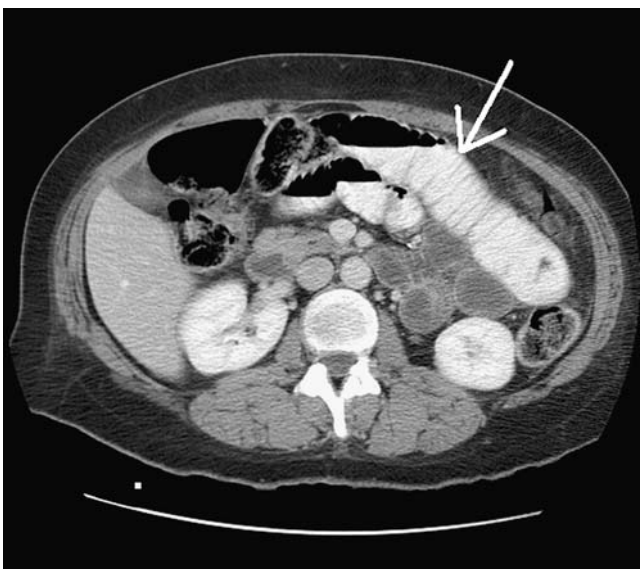

Fig. 2 CT scan demonstrating IH with dilated small bowel loops

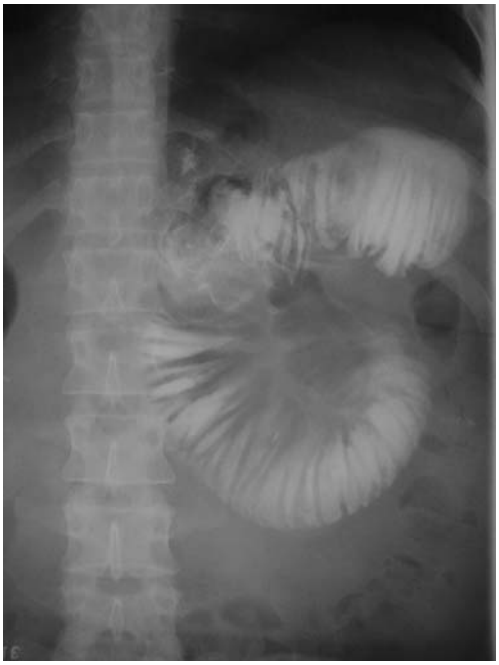

Fig. 3 UGI demonstrating IH. Contrast-filled dilated small bowel loops are seen clustered in the left upper quadrant

delay surgical exploration in sick patients, even in the absence of a positive finding on imaging, in the hope that some less threatening diagnosis is responsible for the patient's condition. Doing so may lead to potentially devastating bowel strangulation and sepsis.

Previous reports have been published regarding the range of radiological findings seen after LRYGB [3,13–24]. Performing diagnostic imaging in the morbidly obese is associated with certain limitations. There are two main modalities used to aid diagnosis in post-LRYGB patients: Computed tomography (CT) and UGI series. CT in postoperative morbidly obese patients may be difficult or impossible because of excessive weight and girth. UGI studies have the advantage that they can be performed with the patient standing and thus there is no weight restriction per se. Technical problems do occur and include difficulty in positioning of patients for optimal radiographs, inability to place the image intensifier over the patient, extreme difficulty during fluoroscopy in depicting intra-abdominal structures, and suboptimal radiographs caused by markedly scattered radiation [18]. On the other hand, spiral CT scanning technology has resulted in shorter scanning time and improved image quality resulting in a detailed view of the anatomy after LRYGB, with all important structures clearly depicted [25]. These factors have contributed to the increased use of this modality for the detection of complications after gastric bypass surgery that might not be readily identified with a conventional UGI series. CT also offers the added advantage of providing guidance for interventional procedures such as aspiration and drainage of fluid collections. CT scanning is, however, more expensive and exposes the patient to greater radiation than UGI series.

With regards to IH diagnosis post-LRYGB, our UGI diagnostic rate of 65% is similar to that reported previously by Blachar et al. who noted six of nine internal hernias correctly diagnosed on UGI in their series of 15 patients presenting with small bowel obstruction [26]. They were able to ascertain from the radiographs that the herniated bowel was usually the Roux limb or the pancreaticobiliary limb. Our series demonstrates a high diagnostic rate (92%) for IH using CT scan. Both Blachar et al. [26] and Yu et al. [24] found CT to only correctly diagnose 66% of IH, but their numbers of IH patients that underwent CT were very low, three in each study. Interestingly, it was noted that the two positive CTs for IH were in the absence of clinical features of bowel obstruction [24]. Others have demonstrated that CT scanning allows an accurate diagnosis of IH after liver transplantation which also necessitates a Roux-en-Y reconstruction [27–29].

Although we would agree that it is difficult to distinguish small bowel obstruction caused by adhesions from that caused by internal hernia on the basis of findings from CT, UGI series, or both; there are certain repeated radiological findings in our series of 56 IH that underwent preoperative diagnostic imaging. In particular the finding of clustered small bowel loops in the left upper quadrant seems to be a fairly specific finding for IH in our study as well as that of Blachar et al. who noted this specific finding was present in 89% of patients with IH [26].

While we were unable to document any association between a particular radiological sign and type of IH (transverse mesocolic vs. enteroenterostomy vs. Peterson's), others have found that the appearance of internal hernias, particularly on CT, depends on their location. Clustering of dilated small bowel loops and crowding and congestion of the mesenteric vessels are generic features seen in all IH cases [13]. But in cases of herniation through the transverse mesocolon, the herniated cluster of bowel is located posterior relative to the stomach (in the lesser sac) and may exert mass effect on its posterior wall. In herniations through the small bowel mesentery, the clustered bowel is pressed against the abdominal wall with no overlying omental fat, causing central displacement of the colon [13]. The same investigators also noted that the Peterson type hernia is difficult to diagnose because it has neither a confining sac nor a characteristic location, and the only clues to its presence may be engorgement and crowding of the mesenteric vessels and evidence of small bowel obstruction.

In our study, 41/56 IH patients had a plain abdominal X-ray (AXR) and 8/56 patients underwent abdominal sonogram. The plain X-rays were requested by our emergency department physicians. Just under half of these were reported as having signs consistent with IH. In fact

there is no radiological sign for IH on plain abdominal radiograph, but the radiologists reports took into account the context in which the X-rays were taken, namely, in post-LRYGB patients with clinical features of subacute bowel obstruction and this, in turn, provided an important clue to the underlying diagnosis. All 19 patients who were noted to have radiological signs of bowel obstruction on plain AXR were confirmed on CT scanning to be positive for IH; however, 11 patients who did not have signs of bowel obstruction on plain AXR were noted to be positive on CT for IH. Unsurprisingly, none of the sonograms were positive for IH, the reason being they were requested to rule out gallbladder pathology (acute cholecystitis) post-LRYGB.

This study has some important limitations. The primary limitation of our study is that it is retrospective, and our study results therefore are compromised by the factors that limit all retrospective studies. In addition, our results are affected by a population bias in that only patients with suspected IH underwent diagnostic imaging. Currently, we do not have imaging data on post-LRYGB patients who are asymptomatic or only mildly symptomatic and yet have IH. Hence we are unable to calculate sensitivity, specificity, and positive and negative predictive values for CT and UGI as diagnostic tests for IH. Another limitation is that regarding the standardization of administration time of oral contrast agents prior to imaging. Unfortunately, this data was not noted and it may influence the diagnostic rate for IH, particularly in the context of CT scanning. However, tolerance of per oral intake in this group of acutely presenting IH patients is limited and some would argue not needed as fluid filled bowel with IV contrast enhancement of bowel wall provides good contrast [30].

Upper gastrointestinal radiography and CT are useful in depicting the normal anatomy after gastric bypass surgery and are complementary in detecting complications after surgery, thus allowing early diagnosis and treatment. Internal hernias present a diagnostic challenge. Preoperative CT scanning indicated the presence of IH in 92% of cases in the current study, the diagnostic rate rising to 100% when CT is combined with UGI examination. Regardless, patients with worrisome findings on presentation should be considered for immediate surgical exploration without radiological work-up.

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