Letter to the Editor

The use of computed tomography in the diagnosis of Petersen's hernia after Billroth II or Roux-en-Y reconstruction for gastric cancer: a description of three cases

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Introduction

Petersen's hernia is an internal hernia that typically occurs after gastrojejunostomy. It happens when part of the patient's intestine or mesentery passes through the Petersen defect (the potential gap between the transverse mesocolon and the input or output loop mesentery after gastrojejunostomy) (1). Petersen's hernia can affect patients of antecolic or retrocolic gastrojejunostomy. It can lead to severe complications, such as small bowel obstruction, intestinal ischemia and infarction, necrosis, and, in severe cases, death (2).

Internal hernia is a rare late complication of laparoscopic Roux-en-Y gastric bypass surgery, with a reported incidence of 0.2% to 9% (3). Petersen's hernia accounts for only 7.5% of all internal hernia cases and is most commonly seen after laparoscopic gastric bypass surgery (4). Internal hernia after open surgery is extremely rare, with an incidence of only approximately 1% (4). However, internal hernia is not only rare, but its clinical symptoms are not typical, and patients usually present to hospital because of abdominal pain, nausea, and vomiting. Therefore, an early diagnosis is particularly important. For clinicians, computed tomography (CT) can provide proof of incarcerated or non-incarcerated Petersen's hernia.

Here, we report three cases of Petersen's hernia that occurred after open Billroth II or Roux-en-Y reconstruction surgery for gastric cancer. Besides, we conducted a comprehensive review of their CT findings to help improve the accuracy of the preoperative diagnosis of Peterson's hernia.

Case presentations

All procedures in this study were performed in accordance with the ethical standards of the West China Hospital's ethics board and the Declaration of Helsinki (as revised in 2013). Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

Case 1

Case 1 was a 60-year-old woman who had undergone open Billroth II reconstruction surgery for gastric cancer 1 month previously. The patient presented with worsening back pain that had started without an apparent precipitating factor 15 hours earlier. The pain was most apparent in the epigastric region, radiating to the back, and was accompanied by nausea and vomiting. A physical examination revealed significant tenderness in the left upper abdomen without rebound tenderness.

CT showed a cluster of the small intestine located in the left middle and upper abdominal region, with the proximal intestine dilating and migrating to the left upper abdominal region. Local mesenteric vessel stretching, mesenteric vessel rotation, and mesenteric fat haziness were observed. The distal superior mesenteric vein (SMV) had a "beaking" sign (*Figure 1*).

Subsequently, the patient underwent exploratory laparotomy. During the procedure, it was found that the distal small intestine had rotated clockwise along the

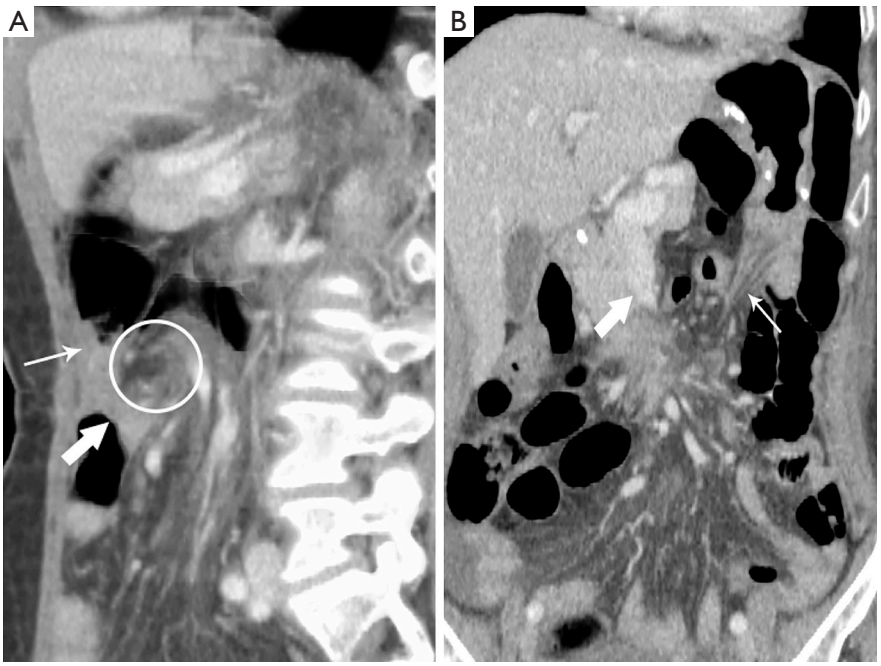

Figure 1 Case 1: a 60-year-old woman with Petersen's hernia. (A) A cluster of small intestine (arrows) located in the left middle and upper abdominal region, and the adjacent mesentery rotates (circle). (B) Superior mesenteric vein (SMV) "beaking" (thick arrow) and mesenteric vessel stretching (thin arrow). The intestine in the left upper abdomen is dilated.

mesenteric root and moved into Petersen's space, resulting in partial displacement of the distal small intestine to the left upper abdomen. The color and peristalsis of the small intestine were normal. The herniated small bowel was repositioned and the gap closed by suturing. The patient recovered well after the operation.

Case 2

Case 2 was a 68-year-old man who had undergone open Billroth II reconstruction surgery for gastric cancer 2 years previously. The patient presented with abdominal pain and distension, nausea, vomiting, and constipation; these symptoms had started without any obvious precipitating factor 1 week prior. A physical examination revealed tenderness in the abdominal wall, without rebound tenderness.

CT imaging showed that the right lower quadrant ileocecal junction had shifted forward, and the terminal ileum had shifted to the left abdomen from upward of the afferent loop. A local small intestinal mesenteric torsion and SMV "beaking" were observed (*Figure 2*).

Exploratory laparotomy revealed herniation and torsion of the distal small intestine from the hiatus above the afferent loop. The twisted small bowel and mesentery were repositioned, and the small intestine was ruddy in color. During the procedure, the gap between the transverse mesocolon and afferent loop was closed.

Case 3

Case 3 was a 64-year-old man who had undergone open distal gastrectomy and Roux-en-Y reconstruction for gastric cancer 7 months previously. The patient had developed persistent pain around the umbilicus and had vomited once after eating breakfast. A physical examination revealed periumbilical tenderness and rebound tenderness.

CT imaging showed that the biliopancreatic loop was located behind the superior mesenteric artery. A local mesenteric torsion could be seen in addition to SMV "beaking". Dilation of the small intestine was observed in the left upper abdomen (*Figure 3*).

The patient underwent exploratory laparotomy a few hours after CT imaging. During the procedure, it was found that the original jejunojejunostomy of the small intestine was twisted at 720° along the mesangium and

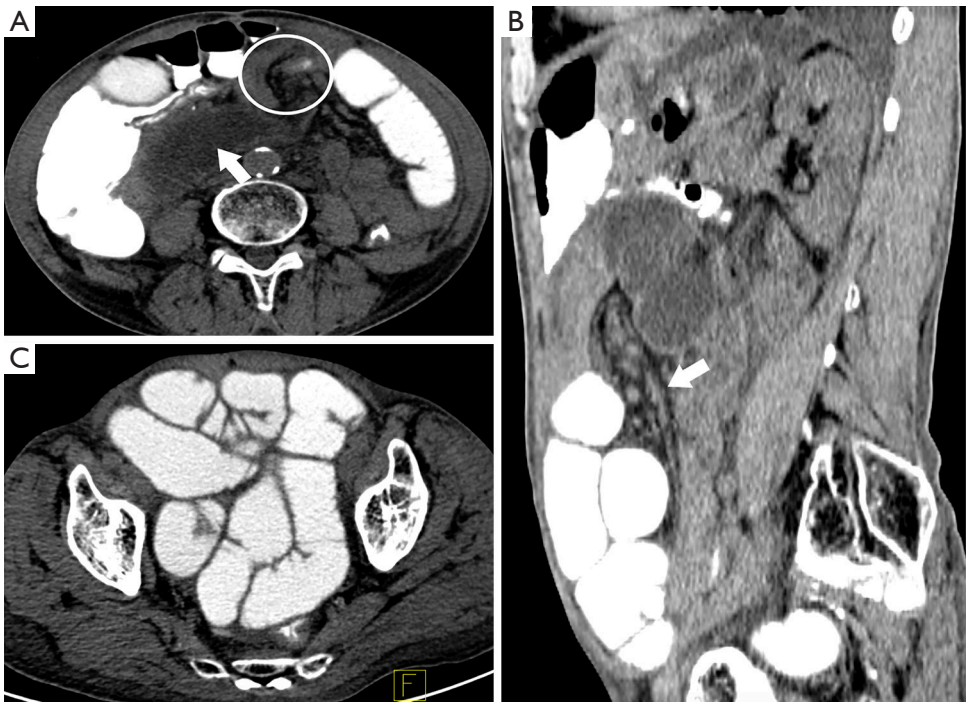

Figure 2 Case 2: a 68-year-old man with Petersen's hernia. (A) Rotation of the mesenteric vessels and intestine (circle) can be seen, in addition to dilation of the afferent loop (arrow). (B) Mesenteric vessel stretching and engorgement (arrow). (C) The intestine in the lower abdomen is dilated and accumulated.

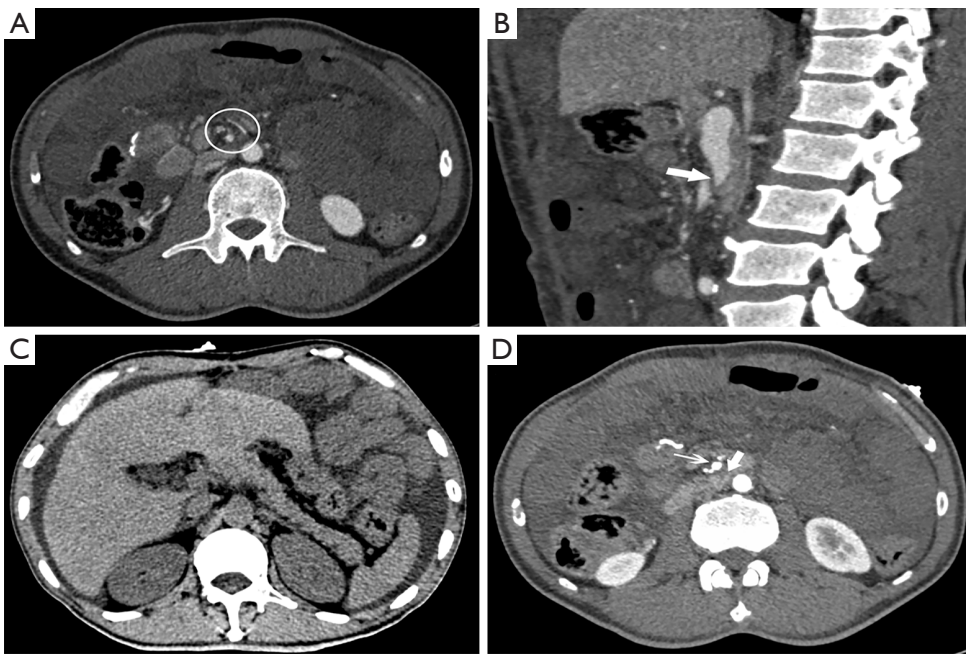

Figure 3 Case 3: a 64-year-old man with Petersen's hernia. (A) The mesentery of the mid-abdomen is twisted and stretched (circle). (B) Superior mesenteric vein (SMV) "beaking" was seen. (C) Dilatation and aggregation of the intestine in the left upper abdomen. (D) The biliopancreatic loop (thick arrow) is located behind the superior mesenteric artery (thin arrow).

herniating into the Petersen's defect. The entire small intestine was congested, swollen, and dark red in color. The small intestine was repositioned and soaked in warm saline, and the patient was given alprostadil to expand the microcirculation. After 1 hour of careful observation, the color and peristalsis of the small intestine had recovered, and the mesangial blood vessels pulsed well. The incision was then closed, and the operation went smoothly.

Discussion

Radical distal gastrectomy is a standard surgical procedure for most tumors affecting the distal part of the stomach (5). There are three surgical options available for reconstruction after distal gastrectomy: Billroth I reconstruction, Billroth II reconstruction, and Roux-en-Y reconstruction. Of these three types of surgery, Billroth I reconstruction is the most common in the treatment of early-stage gastric cancer. This type of reconstruction provides a normal digestive tract, but the relatively high tension at the anastomotic site can lead to complications (6). Moreover, resection of the pylorus in Billroth I reconstruction can cause constant bile reflux, which may be a problem in the long term. Currently, Billroth II and Roux-en-Y reconstruction are more commonly performed for the treatment of locally advanced gastric cancer (7). However, these localized gastric resections are contraindicated in all cases of a diffuse histological type (Lauren classification), in which total gastrectomy (plus lymphadenectomy) is the appropriate treatment. Billroth II reconstruction is easier to perform than Roux-en-Y reconstruction but results in more bile reflux. Therefore, a modified Roux-en-Y reconstruction based on Billroth II reconstruction has been devised to reduce bile reflux. It has been shown that despite reflux gastritis and heartburn symptoms being more common after Billroth II reconstruction than after Roux-en-Y reconstruction, there is no significant difference in patients' nutritional status or quality of life between the two surgical procedures; therefore, both can be used for the treatment of gastric cancer (7). However, with any gastrojejunostomy procedure, there is potential for defects in the abdominal cavity, which can lead to the occurrence of Petersen's hernia (8). In most cases, surgeons can avoid this herniation by closing the defects during the initial surgery (9,10).

Laparoscopic surgery is generally superior to open surgery in terms of reducing pain, reducing blood loss, shortening hospital stay, and improving cosmetic results; as a result, it is often the first choice for doctors (11). However, despite these advantages of laparoscopic surgery, some studies have suggested that intestinal obstruction due to internal hernia is more common after laparoscopic gastric cancer than after open surgery. For example, the incidence of internal hernia following laparoscopic Roux-en-Y gastric bypass surgery has been reported to be between 0.2% and 9% (3). In some studies, the incidence of internal hernia after laparoscopic surgery is in the range of 1% to 4%, whereas after open surgery it is less than 1% (4,12). The higher incidence of internal hernia after laparoscopic bypass surgery may be because laparoscopic surgery reduces tissue trauma, which decreases the probability of tissue adhesion compared with laparotomy. Without adhesions, the small intestine can move freely, which increases the probability of herniation into the potential space generated by surgery (13).

The transverse mesocolon forms a natural barrier between the stomach and small intestine. After the establishment of either type of gastrojejunostomy, antecolic or retrocolic, a potential defect between the limbs of the small intestine and the transverse mesocolon can result in the formation of internal hernias. Some studies have found differences in the incidence of internal hernia between the antecolic and retrocolic routes (14-17). Some studies have suggested that the incidence of internal hernia can be reduced by placing the limbs of the small intestine in front of the transverse colon (14,15). In a meta-analysis by Al Harakeh *et al.* (16), internal hernias were reported in 1.3% of patients in the antecolic route group, compared with 2.3% of patients in the retrocolic route group. In contrast, others have found no significant difference in the incidence of internal hernia between the antecolic and retrocolic routes (17). Although the antecolic route can significantly reduce the operation time, it can also increase the tension at the gastrointestinal anastomosis and elevate the risk of anastomotic leakage and stenosis (17,18). Therefore, surgeons should choose the most appropriate surgical procedure according to the patient's condition and their own experience.

Potential mesenteric defects are one of the major causes of internal hernia after gastrojejunostomy. Although there are no guidelines for the closure of mesenteric defects, some researchers have investigated this issue. For example, Sun *et al.* (19) considered that the omission of a procedure closure technique was one of the reasons for the increased incidence of Petersen's hernia after gastrojejunostomy. Furthermore, Blockhuys *et al.* (9) suggested that closing both mesenteric and Petersen's defects could significantly reduce the incidence of internal hernia, and in their study,

Kojima *et al.* (20) showed that the incidence of Petersen's hernia decreased from 5.1% to 1.7% by using absorbable sutures to seal the Petersen's defect. Other studies have suggested that the incidence of internal hernia can be reduced by using non-absorbable suture materials (4,21). However, because of the effects of suture techniques and follow-up time, among other factors, no consistent conclusion has been reached.

Internal hernia can cause severe complications, such as small bowel obstruction followed by bowel ischemia, and in severe cases, death (2). However, its clinical symptoms are not typical, and patients usually present to hospital because of abdominal pain, nausea, and vomiting. Therefore, an early diagnosis is particularly important. Abdominal CT has certain advantages in the diagnosis of internal hernia. The following seven CT signs have been described as being typical of internal hernia: the swirl, small bowel obstruction, mushroom, clustered loops, hurricane eye, small bowel behind the superior mesenteric artery, and right-sided anastomosis signs (22). Recently, two new CT signs have been added: SMV "beaking" and a "criss-cross" appearance of the second-order mesenteric vessels (23). At present, research suggests that mesenteric swirl, small bowel obstruction, and SMV "beaking" are the best indicators for the diagnosis of internal hernia, with mesenteric swirl having a sensitivity of 70% to100%, and small bowel obstruction and SMV "beaking" having a specificity of 70% to 94% and 94% to 95%, respectively (9,23,24). However, it remains challenging to distinguish the four types of internal hernia on CT. A 2011 study on the CT signs of four types of internal hernia found that the key to distinguishing them lies in identifying anatomical landmarks and determining the position of clustered small bowel loops and the hernial orifice (25). In all three cases of Petersen's hernia reported herein, mesenteric swirl and SMV "beaking" were observed; in addition, the location of the hernial orifice of Petersen's hernia helped us determine the type of internal hernia in all three cases.

To sum up, to prevent the occurrence of internal hernia, appropriate surgical procedures and suture techniques should be carefully selected. In particular, the internal gap needs to be closed by suturing during the operation. Because internal hernia can lead to severe complications, more attention should be paid to patients with symptoms such as nausea, vomiting, and abdominal pain, and to those with a previous history of gastrojejunostomy. Also, timely CT examination is needed for a definite diagnosis of internal hernia. If there is a possibility that a patient has an internal hernia, surgical exploration should be performed as soon as possible.

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Footnote

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://qims.amegroups.com/article/view/10.21037/qims-21-1225/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures in this study were performed in accordance with the ethical standards of the West China Hospital's ethics board and the Declaration of Helsinki (as revised in 2013). Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

References

1. Sebesta DG, Robson MC. Petersen's retroanastomotic hernia. Am J Surg 1968;116:450-3.
2. Carucci LR, Turner MA, Shaylor SD. Internal hernia following Roux-en-Y gastric bypass surgery for morbid obesity: evaluation of radiographic findings at small-bowel examination. Radiology 2009;251:762-70.
3. Patel RY, Baer JW, Texeira J, Frager D, Cooke K. Internal hernia complications of gastric bypass surgery in the acute setting: spectrum of imaging findings. Emerg Radiol 2009;16:283-9.

4. Higa KD, Ho T, Boone KB. Internal hernias after laparoscopic Roux-en-Y gastric bypass: incidence, treatment and prevention. Obes Surg 2003;13:350-4.
5. Kim JP. Current status of surgical treatment of gastric cancer. J Surg Oncol 2002;79:79-80.
6. Kang KC, Cho GS, Han SU, Kim W, Kim HH, Kim MC, Hyung WJ, Ryu SY, Ryu SW, Lee HJ, Song KY; Korean Laparoscopic Gastrointestinal Surgery Study (KLASS) Group. Comparison of Billroth I and Billroth II reconstructions after laparoscopy-assisted distal gastrectomy: a retrospective analysis of large-scale multicenter results from Korea. Surg Endosc 2011;25:1953-61.
7. So JB, Rao J, Wong AS, Chan YH, Pang NQ, Tay AYL, Yung MY, Su Z, Phua JNS, Shabbir A, Ng EKW. Roux-en-Y or Billroth II Reconstruction After Radical Distal Gastrectomy for Gastric Cancer: A Multicenter Randomized Controlled Trial. Ann Surg 2018;267:236-42.
8. Liu S, Hu Q, Song P, Tao L, Ai S, Miao J, Wang F, Kang X, Shen X, Sun F, Xia X, Wang M, Lu X, Guan W. Risk Factor and Surgical Outcome of Petersen's Hernia After Gastrectomy in Gastric Cancer. Front Oncol 2021;11:765509.
9. Blockhuys M, Gypen B, Heyman S, Valk J, van Sprundel F, Hendrickx L. Internal Hernia After Laparoscopic Gastric Bypass: Effect of Closure of the Petersen Defect - Single-Center Study. Obes Surg 2019;29:70-5.
10. Murakami K, Obama K, Kanaya S, Satoh S, Manaka D, Yamamoto M, Kadokawa Y, Itami A, Okabe H, Hata H, Tanaka E, Yamashita Y, Kondo M, Hosogi H, Tsunoda S, Hisamori S, Nishigori T, Sakai Y. Mesenteric closure after laparoscopic total gastrectomy with Roux-en-Y reconstruction is effective for prevention of internal hernia: a multicenter retrospective study. Surg Endosc 2021. [Epub ahead of print].
11. Parisi A, Reim D, Borghi F, Nguyen NT, Qi F, Coratti A, et al. Minimally invasive surgery for gastric cancer: A comparison between robotic, laparoscopic and open surgery. World J Gastroenterol 2017;23:2376-84.
12. Faria G, Preto J, Oliveira M, Pimenta T, Baptista M, Costa-Maia J. Petersen's space hernia: A rare but expanding diagnosis. Int J Surg Case Rep 2011;2:141-3.
13. Capella RF, Iannace VA, Capella JF. Bowel obstruction after open and laparoscopic gastric bypass surgery for morbid obesity. J Am Coll Surg 2006;203:328-35.
14. Leyba JL, Navarrete S, Navarrete Llopis S, Sanchez N, Gamboa A. Laparoscopic technique for hernia reduction and mesenteric defect closure in patients with internal hernia as a postoperative complication of laparoscopic Roux-en-Y gastric bypass. Surg Laparosc Endosc Percutan Tech 2012;22:e182-5.
15. Escalona A, Devaud N, Pérez G, Crovari F, Boza C, Viviani P, Ibáñez L, Guzmán S. Antecolic versus retrocolic alimentary limb in laparoscopic Roux-en-Y gastric bypass: a comparative study. Surg Obes Relat Dis 2007;3:423-7.
16. Al Harakeh AB, Kallies KJ, Borgert AJ, Kothari SN. Bowel obstruction rates in antecolic/antegastric versus retrocolic/retrogastric Roux limb gastric bypass: a meta-analysis. Surg Obes Relat Dis 2016;12:194-8.
17. Ribeiro-Parenti L, Arapis K, Chosidow D, Dumont JL, Demetriou M, Marmuse JP. Gastrojejunostomy stricture rate: comparison between antecolic and retrocolic laparoscopic Roux-en-Y gastric bypass. Surg Obes Relat Dis 2015;11:1076-84.
18. Eckhauser A, Torquati A, Youssef Y, Kaiser JL, Richards WO. Internal hernia: postoperative complication of roux-en-Y gastric bypass surgery. Am Surg 2006;72:581-4; discussion 584-5.
19. Sun KK, Wu YY. Current status of internal hernia after gastrectomy for gastric cancer. Langenbecks Arch Surg 2022;407:99-104.
20. Kojima K, Inokuchi M, Kato K, Motoyama K, Sugihara K. Petersen's hernia after laparoscopic distal gastrectomy with Roux-en-Y reconstruction for gastric cancer. Gastric Cancer 2014;17:146-51.
21. Schneider R, Schulenburg M, Kraljević M, Klasen JM, Peters T, Wölnerhanssen B, Peterli R. Does the non-absorbable suture closure of the jejunal mesenteric defect reduce the incidence and severity of internal hernias after laparoscopic Roux-en-Y gastric bypass? Langenbecks Arch Surg 2021;406:1831-8.
22. Lockhart ME, Tessler FN, Canon CL, Smith JK, Larrison MC, Fineberg NS, Roy BP, Clements RH. Internal hernia after gastric bypass: sensitivity and specificity of seven CT signs with surgical correlation and controls. AJR Am J Roentgenol 2007;188:745-50.
23. Dilauro M, McInnes MD, Schieda N, Kielar AZ, Verma R, Walsh C, Vizhul A, Petrcich W, Mamazza J. Internal Hernia after Laparoscopic Roux-en-Y Gastric Bypass: Optimal CT Signs for Diagnosis and Clinical Decision Making. Radiology 2017;282:752-60.
24. Iannuccilli JD, Grand D, Murphy BL, Evangelista P, Roye GD, Mayo-Smith W. Sensitivity and specificity of eight CT signs in the preoperative diagnosis of internal mesenteric hernia following Roux-en-Y gastric bypass surgery. Clin Radiol 2009;64:373-80.

25. Kawkabani Marchini A, Denys A, Paroz A, Romy S, Suter M, Desmartines N, Meuli R, Schmidt S. The four different types of internal hernia occurring after laparascopic Roux-en-Y gastric bypass performed for morbid obesity: are there any multidetector computed tomography (MDCT) features permitting their distinction? Obes Surg 2011;21:506-16.

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