Original Article

Computed Tomography Definitive Findings of Petersen's Hernia

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Abstract: Purpose: Petersen's hernia is a type of internal hernia in which the intestine moves into the potential space between the caudal surface of the transverse mesocolon and the mesentery of the Roux limb. We examined computed tomographic (CT) findings of Petersen's hernias after Roux-en-Y reconstruction for gastric cancer.

Materials: This retrospective study included 4 patients with surgically proven Petersen's hernias between January 2008 and December 2015.

Results: The CT images from all 4 patients showed that in addition to the transverse colon, the small intestines ran behind the mesenteric vessels of the Roux limb. The angle of Treitz was displaced anteriorly in left-to-right direction hernia and inferiorly in the right-to-left direction hernia. The mushroom shape of the mesentery was observed only in the left-to-right direction hernia.

Conclusion: Small intestines running behind the mesenteric vessels of the Roux limb are a characteristic CT finding of Petersen's hernia.

Key Words: Petersen's hernia, Roux-en-Y reconstruction, Computed tomography.

Introduction

Petersen's hernia is a specific type of internal hernia in which the intestine moves into the potential space (Petersen's space) between the caudal surface of the transverse mesocolon and the mesentery of the Roux limb[1-3]. The mechanism of this hernia is explained in Fig. 1. A 2.2% incidence of Petersen's hernia after gastrectomy for gastric cancer with Roux-en-Y reconstruction has been reported earlier[2]. It can

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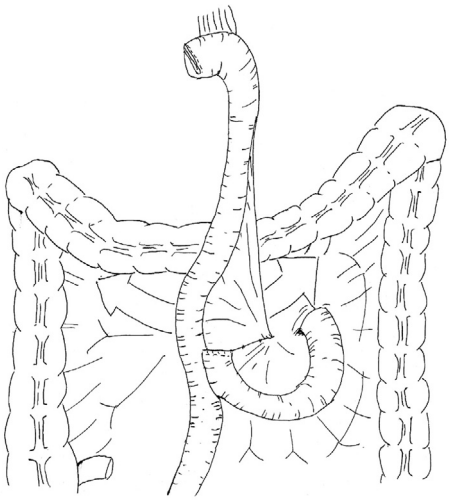

Fig. 1 The scheme of the Petersen's hernia

occur in both antecolic and retrocolic anastomoses. Published studies on Petersen's hernia have described computed tomography (CT) findings such as mesenteric swirl and haziness in the mesenteric fat, intestinal distention in the upper abdomen, mesenteric vessel elongation, a mushroom-like appearance of the mesentery, and displacement of the angle of Treitz anteriorly and to the right. In addition, the middle/distal ileum has been observed to course downwards into the left hypochondrium[4,9]. However, these findings are not sufficiently sensitive for diagnosing Petersen's hernia[5)6)8)].

Normally, in antecolic anastomosis, only the transverse colon passes between the mesenteric vessels of the Roux limb from the mesenteric root. Therefore, we hypothesize that small intestines passing behind the mesenteric vessels of the Roux limb are a characteristic CT finding of Petersen's hernia. In this study, we evaluated the CT findings of patients with Petersen's hernia after antecolic Roux-en-Y reconstruction and reviewed some of the previously published CT findings of Petersen's hernia.

Materials and methods

Clinical data and symptoms of patients (Table 1)

Electronic medical records from January 2008 to December 2015 at our institution were searched, and

Table 1

Case	Age	Sex	Interval	The operative procedures for preceding gastrectomies	symptoms
1	72	M	6 months	open total gastrectomy	abdominal pain
2	76	M	7 months	open total gastrectomy	abdominal pain vomiting
3	82	M	30 years	open subtotal gastrectomy	abdominal pain
4	81	M	4 years	laparoscopic subtotal gastrectomy	abdominal pain

☆ Interval: interval betweeen gastrectomy and Petersen's hernia

the CT images of four male patients with surgically proven Petersen's hernias were reviewed. Of them, two patients underwent distal gastrectomy for gastric cancer with antecolic Roux-en-Y reconstruction, and other two patients underwent total gastrectomy for gastric cancer with antecolic Roux-en-Y reconstruction. Their symptoms at presentation included vomiting and abdominal pain.

Imaging technique

All patients had undergone contrast-enhanced CT imaging. CT was performed in the axial plane with a slice thickness of 1.25 mm or 2.5 mm using two helical CT scanner models (LightSpeed Ultra, GE Healthcare, Waukesha, Wisconsin, USA; Optima, GE Healthcare, Waukesha, Wisconsin, USA). Contrast media (100 mL) with an iodine concentration of 300 mg I/mL (iopamidol 300; Bayer Health Care, Osaka, Japan) was injected at a flow rate of 1.5 mL/s using a power injector (Advanced CT Contrast Delivery DUAL SHOT; Nemoto Kyorindo, Tokyo, Japan). No oral contrast media was administered. Multiplanar reformation was used to evaluate the CT findings.

Evaluations

Two radiologists (with 4 and 30 years of experience) consensually reviewed the following in the CT scans:

(1) whether the small intestines pass behind the mesenteric vessels of the Roux limb
(2) stenosis of the herniated intestines in Petersen's defect
(3) the presence of swirled mesentery and haziness in the mesenteric fat
(4) the position of the angle of Treitz
(5) mushroom shape of the mesenteric root

Results

(Table 2 presents the CT findings)

The CT images of all 4 patients revealed that the small intestines passed behind the mesenteric vessels of the Roux limb, as we had hypothesized. In Petersen's hernia with a left-to-right direction, the biliopancreatic limb, Roux limb, and distal small intestine moved into Petersen's space, and the angle of Treitz was displaced anteriorly and to the right. In the right-to-left direction, the jejunum distal to anastomosis and the distal intestine moved into Petersen's space, and the angle of Treitz was displaced inferiorly and to the left. The mushroom shape of the mesentery was observed only in the left-to-right direction.

The swirled mesentery was observed in three patients, while haziness in the mesenteric fat was observed in all patients. Not all small intestines showed stenosis in the Petersen's defect. Further, in a

Table 2

Case	Direction	Where intestines passed behind the mesenteric vessels of the Roux limb?	intestinal stenosis	swirled mesentery	mesenteric fat haziness	treitz angle	mushroom shape
1	L/R	biliopancreatic limb, Roux limb, distal intestine	all intestines	+	+	anteriorly to right	+
2	L/R	biliopancreatic limb, Roux limb, distal intestine	Roux limb	+	+	anteriorly to right	+
3	R/L	Jejunum after anastomosis, distal intestine	biliopancreatic limb	−	+	inferiorly to left	−
4	R/L	Jejunum after anastomosis, distal intestine	distal intestine	+	+	inferiorly to left	−

☆ direction: L/R: from the left to the right side, R/L: from the right to the left side

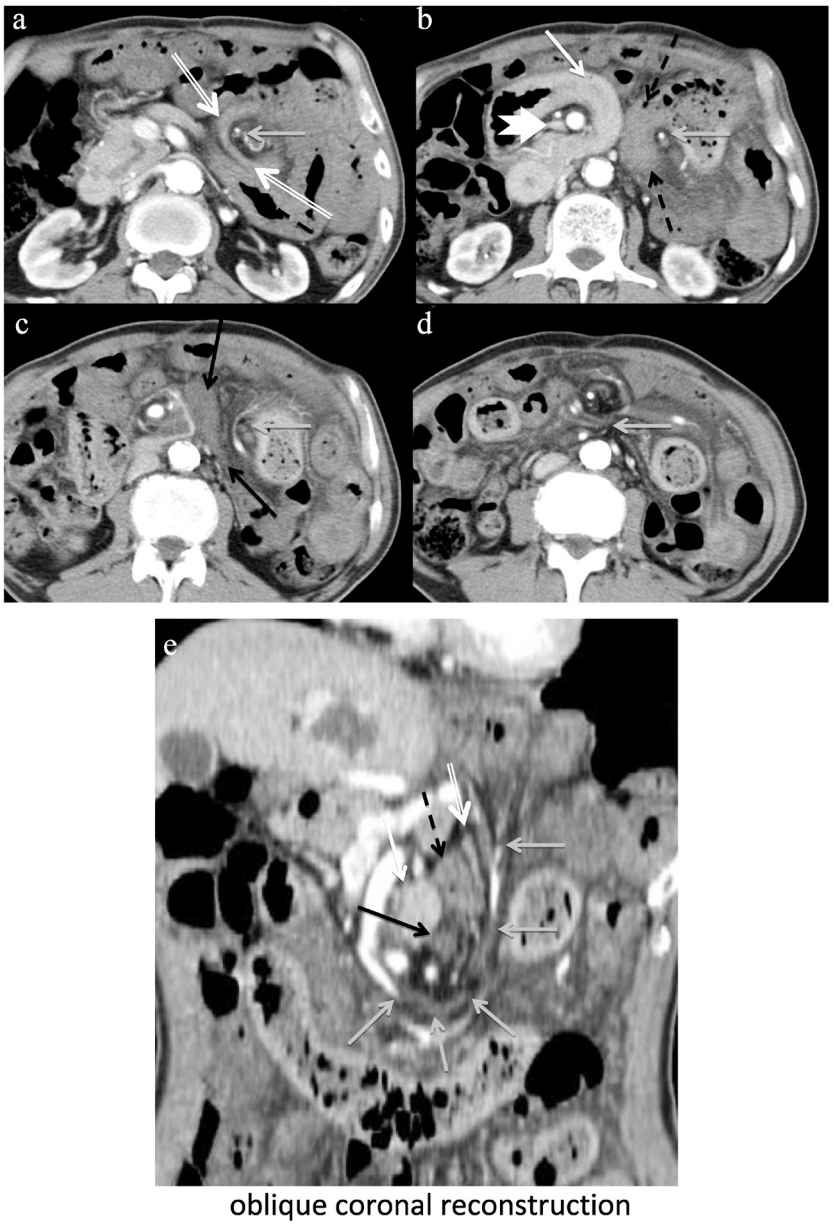

Fig. 2 A 72-year-old man who presented to our hospital 6 months after a total gastrectomy

(a)-(d) Enhanced transverse CT scans through the mesenteric root showed that the transverse colon (double white arrow), biliopancreatic limb (white arrow), Roux limb (black dash arrow), and distal small intestine (black arrow) passed between the SMA and the mesenteric branch (gray arrow). The swirled appearance of the mesenteric vessels and stenosis of the superior mesenteric vein (white arrow head) were observed. Associated mesenteric edema appeared as an increased attenuation of mesenteric fat. The angle of Treitz was displaced anteriorly and to the right. The mushroom shape of the mesenteric root was also observed. (e) The oblique coronal reconstruction presents that the transverse colon and the herniated small intestines passes between the mesenteric vessels of the Roux limb from the mesenteric root.

Operation record: The small intestines had passed through Petersen's defect from the left side to the right side. The edematous bowels were ischemic.

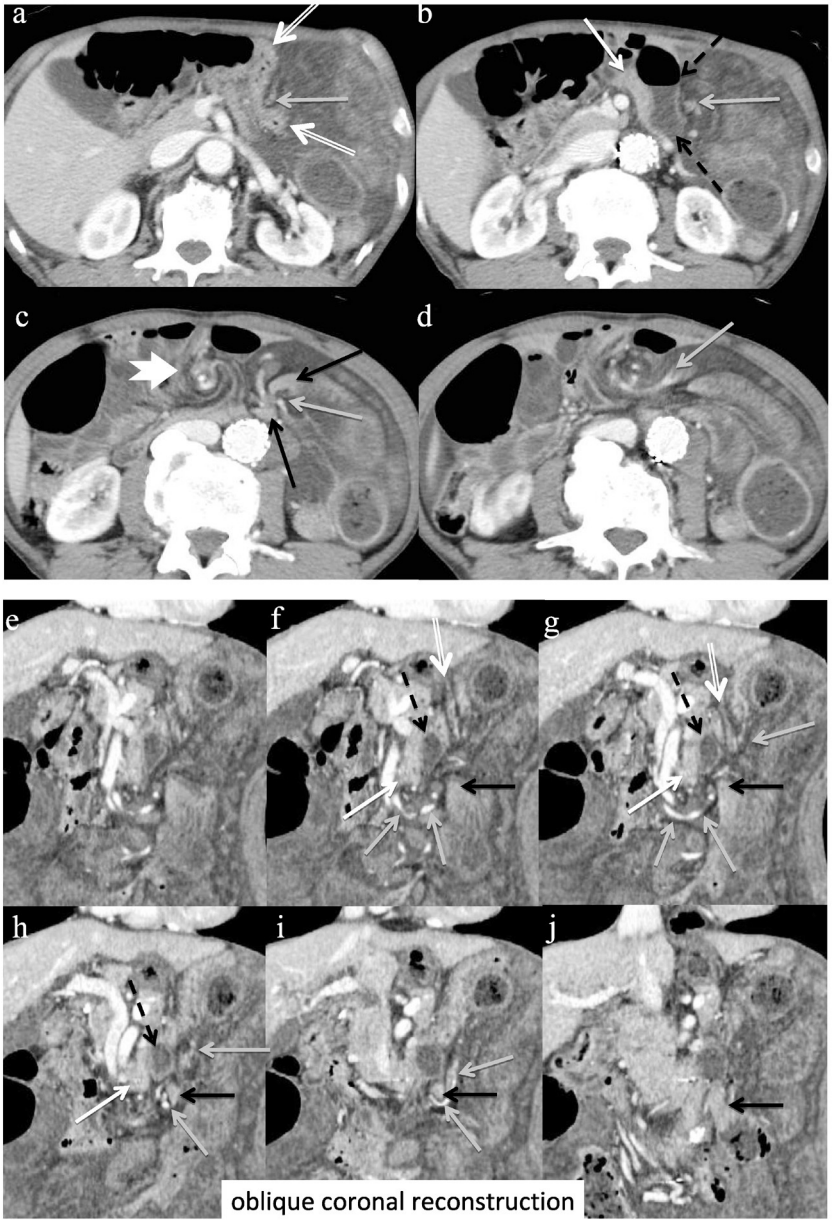

Fig. 3 A 76-year-old man who presented to our hospital 7 months after a total gastrectomy

(a)-(d) The transverse colon (double white arrow), biliopancreatic limb (white arrow), Roux limb (black dash arrow), and distal small intestine (black arrow) passed behind the mesenteric vessels of the Roux limb (gray arrow). Enhanced transverse CT scans through the mesentery showed a swirled appearance of the mesenteric vessel in the SMA region (white arrow head). Associated mesenteric edema appeared as an increased attenuation of mesenteric fat. The angle of Treitz was displaced anteriorly and to the right. The mushroom-shape appearance was also observed. (e)-(j) The oblique coronal reconstruction presents that the transverse colon and the herniated small intestines passes between the mesenteric vessels of the Roux limb from the mesenteric root.

Fig. 4 Three months earlier CT scan of the same patient
(a)-(d) CT had revealed findings consistent with Petersen's hernia, but the swirled mesentery and mesenteric fat haziness were not seen at this study.
Operation record: The small intestines herniated through the Petersen's defect from left to right.

patient (Patient 2), even the CT images obtained before acute abdomen displayed signs of Petersen's hernia.

Discussion

Petersen's hernia is a herniation of the small intestine behind the Roux limb. Laparoscopic distal gastrectomy is increasingly used for gastric cancer, leading to an increased incidence of Petersen's hernia[2)3)]. Patients typically present with vague abdominal pain, nausea, and occasional vomiting. Preoperative diagnosis is often difficult because the symptoms and laboratory examinations are nonspecific[10)]. Therefore, imaging examinations play an important role in the early diagnosis and treatment of this condition, and CT provides the most accurate diagnosis.

Previously published reports of Petersen's hernia attempted to use several CT findings to diagnose these patients. However, the reported indications were not sufficiently sensitive. Normally, in antecolic anastomosis, only the transverse colon passes between the mesenteric vessels of the Roux limb from the mesenteric root[1)]. Therefore, we hypothesized that the passing of the small intestines behind the mesenteric vessels of the Roux limb represented a characteristic feature of Petersen's hernia and retrospectively evaluated the CT findings of patients with Petersen's hernia.

The CT images of all four patients revealed that in addition to the transverse colon, the small intestines ran behind the mesenteric vessels of the Roux limb. Oblique coronal reconstructions were generated along the superior mesenteric artery and its branches. Using these reconstructions, the Petersen's defect could

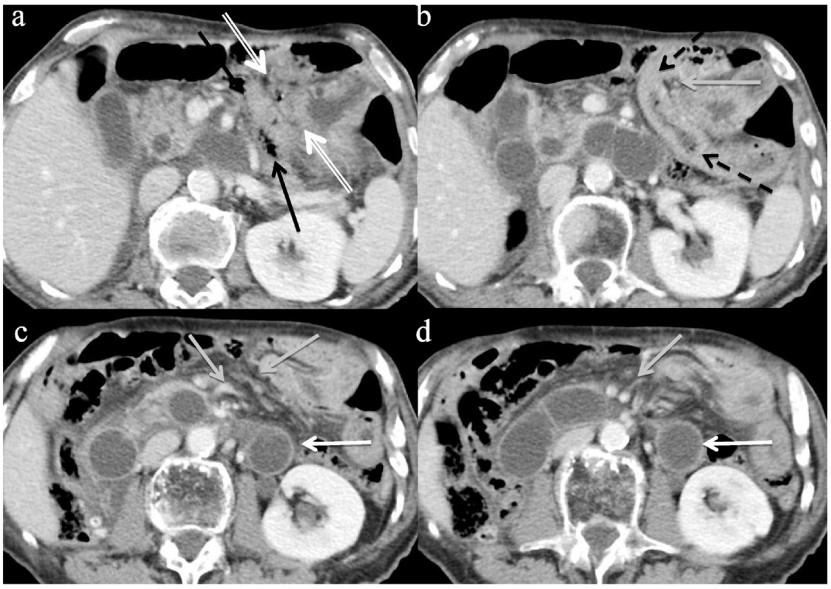

Fig. 5 An 82-year-old man who presented to our hospital 30 years after a subtotal gastrectomy

(a)-(d) The transverse colon (double white arrow), the jejunum distal to the jejuno-jejunal anastomosis (black dash arrow) and the distal small intestine (black arrow) passed between the Roux limb loop (gray arrow) with duodenal dilatation on CT images. The angle of Treitz (white arrow) was displaced inferiorly and to the left. The mushroom shape of the mesentery was not seen.

Operation record: The small intestine distal to the jejuno-jejunal anastomosis herniated into the Petersen's defect from the right to the left.

be easily identified. Hongo et al. reported that assessment of a hernial orifice using multi planar reformation is useful for the diagnosis of an internal hernia after Roux-en-Y reconstruction[8].

In Petersen's hernia with a left-to-right direction, the biliopancreatic limb, Roux limb, and distal small intestine had moved into Petersen's space, and the angle of Treitz was displaced anteriorly and to the right. The herniated biliopancreatic limb and Roux limb formed a mushroom shape. In Petersen's hernia with a right-to-left direction, the biliopancreatic limb did not pass through this space and the angle of Treitz was displaced inferiorly and to the left. As the mesenteric root does not get herniated, the mushroom shape was not observed. In patients with acute abdomen onset, haziness in the mesenteric fat was observed in all of them. However, there were no stenosis in the small intestines of all patients with passed Petersen's space, and in one patient, previous CT images also showed findings consistent with Petersen's hernia. Therefore, we speculated that bowel ischemia due to the stretching or torsion of the mesenteric vessels contributes to the onset of symptoms. Although swirled mesentery and haziness in the mesenteric fat are not specific findings of Petersen's hernia, these are important as CT findings indicating the bowel ischemia. These signs will be indication of emergency operation.

Our study had some limitations. First, this study was retrospective. Second, the study group was small because Petersen's hernia is uncommon. However, we think that this finding is natural when considering the anatomical principle of the Petersen's hernia.

In conclusion, we have demonstrated in this study that small intestines passing behind the mesenteric vessels of the Roux limb represent a characteristic CT finding of Petersen's hernia and thus will be useful for assessing patients at post-gastrectomy state with abdominal symptoms.

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Conflict-of-interest statement

The authors have no conflicts of interest to declare.

References

1) Sunnapwar A, Sandrasegaran K, Menias CO, Lockhart M, Chintapalli KN, Prasad SR. Taxonomy and Imaging Spectrum of Small Bowel Obstruction After Roux-en-Y Gastric Bypass Surgery. AJR Am J Roentgenol 2010; 194: 120-128.
2) 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: 146-151.
3) Yoshikawa K, Shimada M, Kurita N, Sato H, Iwata T, Higashijima J, Chikakiyo M, Nishi M, Kashihara H, Takasu C, Matsumoto N, Eto S. Characteristics of internal hernia after gastrectomy with Roux-en-Y reconstruction for gastric cancer. Surg Endosc 2014; 28: 1774-1778.
4) Blachar A, Federle MP, Pealer KM, Ikramuddin S, Schauer PR. Gastrointestinal complications of laparoscopic Roux-en-Y gastric bypass surgery: clinical and imaging findings. Radiology 2002; 223: 625-632.
5) 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: 745-750.
6) 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: 373-380.
7) Ximenes MAS, Baroni RH, Trindade RMC, Racy MCJ, A. Tachibana, Moron RA, Funari MBG. Petersen' s hernia as a complication of bariatric surgery: CT findings. Abdom Imaging 2011; 36: 126-129.
8) Hongo N, Mori H, Matsumoto S, Okino Y, Takaji R, Komatsu E. Internal hernias after abdominal surgeries: MDCT features. Abdom Imaging 2011; 36: 349-362.
9) Doishita S, Takeshita T, Uchima Y, Kawasaki M, Shimono T, Yamashita A, Sugimoto M, Ninoi T, Shima H, Miki Y. Internal Hernias in the Era of Multidetector CT: Correlation of Imaging and Surgical Findings. Radiographics 2016; 36: 88-106.
10) Fabozzi M, Contul RB, Millo P, Allieta R. Intestinal infarction by internal hernia in Petersen's space after laparoscopic gastric bypass. World J Gastroenterol 2014; 20: 16349-16354.

〈和文抄録〉

ペーターソンヘルニア

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目的：ペーターソンヘルニアは横行結腸間膜の尾側面と，挙上したRoux脚の腸間膜との間にできた間隙（ペーターソン間隙）に小腸が入り込む内ヘルニアの1型である．我々は胃癌術後のペーターソンヘルニアのCT所見を検討した．

方法：2008年1月から2015年12月の間に手術で診断された4例を後方視的に検討した．

結果：全例のCT所見とも，Roux脚の腸間膜内の血管より背側に小腸が走行していた．トライツは左から右方向のヘルニアでは前方に，右から左方向のヘルニアでは尾側に偏位していた．腸間膜のマッシュルーム形態は左から右方向のヘルニアで観察された．

結語：小腸がRoux脚の腸間膜内の血管より背側に走行することが，ペーターソンヘルニアの特徴的なCT所見である．

キーワード：ペーターソンヘルニア，Roux脚，Computed tomography.