ABSTRACT

Objectives: To describe tomographic findings in Petersen’s hernia associated with laparoscopic Roux-en-Y gastric bypass surgery.

Methods: Two radiologists, experts in abdominal radiology, independently and retrospectively reviewed four cases of Petersen’s hernia confirmed surgically in three patients, between March 2007 and July 2008, who had undergone laparoscopic Roux-en-Y gastric bypass surgery with an antecolic anastomosis for treating morbid obesity. The main imaging findings were the presence and location of abdominal distention, the herniated intestinal loop segment, the presence of mesenteric vessel rotation and haziness of mesenteric fat, the position of the Treitz angle ligament and the course of the ileum.

Results: In all cases, abdominal distention was located in the upper abdomen; the herniated jejunal loop was located above the gastric level; mesenteric vessel rotation was associated with mesenteric fat haziness; the middle/distal ileum descended from the left hypochondrium; and the Treitz angle was displaced anteriorly and to the right. Both examiners fully agreed with the analysis of findings.

Conclusions: The association of computed tomography findings described in patients with a history of bariatric surgery is a strong predictor of Petersen’s hernia.

Keywords: Hernia; Tomography, X-ray computed; Gastroplasty/methods; Postoperative complications

RESUMO

Objetivo: Descrever os achados tomográficos associados à hérnia de Petersen em pacientes submetidos à gastroplastia redutora com Y de Roux.

Métodos: Foram analisados retrospectivamente, por dois observadores independentes, quatro casos com diagnóstico cirúrgico confirmado de hérnia de Petersen, ocorridos em três pacientes no período de Março de 2007 a Julho de 2008, todos submetidos a bypass gástrico através de Y de Roux por via videolaparoscópica com anastomose antecólica para tratamento de obesidade mórbida. Os principais aspectos analisados nas imagens foram a presença e a localização da distensão abdominal; o segmento de alça intestinal herniado; a presença de rotação dos vasos mesentéricos e densificação da gordura do mesentério; a posição do ângulo de Treitz, e o trajeto do íleo.

Resultados: Em todos os casos analisados, foram caracterizados os seguintes achados: distensão abdominal no andar superior do abdome; localização do segmento herniado de alça jejunal acima do nível gástrico; rotação dos vasos mesentéricos acompanhada de densificação da gordura mesentérica; trajeto descendente do íleo médio/distal a partir do hipocôndrio esquerdo; e o deslocamento anterior e para a direita do ângulo de Treitz. Houve concordância total entre os dois examinadores na análise destes achados.

Conclusões: Os achados tomográficos descritos, quando encontrados nos exames de tomografia computadorizada em pacientes submetidos à gastroplastia redutora, são fortes precursores de hérnia de Petersen.
**INTRODUCTION**

Obesity is a chronic disease characterized by excessive accumulation of adipose tissue in the body. It has become the most prevalent public health issue worldwide; according to statistics of the Centers for Disease Control and Prevention (CDC), 64% of North Americans are above the overweight range\(^1\). Given the multifactorial etiology of obesity, its treatment requires a variety of approaches.

Conventional medical therapy for morbid obesity continues yielding unsatisfactory results; 95% of patients return to their initial weight within two years. Referrals for bariatric surgery have currently increased due to the need for more effective interventions in the management of severely obese patients\(^2-4\). Candidates for surgery are patients with a Body Mass Index (BMI) above 40 kg/m\(^2\) or a BMI over 35 kg/m\(^2\) associated with comorbidities, such as sleep apnea, type 2 diabetes mellitus, arterial hypertension, dyslipidemia and difficulty ambulation, among other conditions that are difficult to manage medically\(^5-8\).

The Roux-en-Y gastric bypass is currently one of the preferred procedures. The minimum amount of the gastrointestinal tract that is excluded from intestinal transit is the distal stomach, the duodenum, and about 40 cm of the proximal jejunum. The standard Roux loop measures about 75 cm. The gastric bypass may be done by open surgery or laparoscopy, the latter being currently preferred\(^9-10\). The upper pouch is made horizontally or vertically, and has a capacity of about 15 to 25 ml; the distal stomach is separated or fully excluded. An anastomosis (proximal anastomosis) is done between this small pouch and part of the jejunum (feeding loop) that was sectioned close to its origin\(^10\). The afferent or biliopancreatic loop starts from the remaining stomach, passing along the duodenum until the proximal jejunum, in which the jejuno-jejunal anastomosis (distal anastomosis) is performed. The anastomotic loop may be retrocolic or antecolic. The retrocolic anastomosis creates space in the mesentery, opening the possibility of a transmesenteric hernia. Petersen’s hernia may occur in both types of anastomosis\(^9-10\) (Figure 1).

Internal hernias are the main causes of late postoperative intestinal obstruction; its incidence reaches up to 9.7%\(^9\). Petersen’s hernia is a less common finding in most published papers compared to transmesocolic hernia\(^10-11\). Imaging exams have an important role in the early diagnosis and surgery of this condition, with multislice computed tomography being the most accurate method in such cases.

**OBJECTIVE**

The purpose of this study was to describe the tomographic findings of internal hernias along Petersen’s space (Petersen’s hernia) following Roux-en-Y gastric bypass surgery.

**METHODS**

A review was made of all abdominal computed tomography exams done in the Image Department of Hospital Israelita Albert Einstein, stored in the Picture Archiving and Communications System (PACS), to select those patients with a tomographic diagnosis of internal hernias. Three patients with a confirmed surgical diagnosis of Petersen’s hernia, between March 2007 and July 2008, were selected. All three had undergone laparoscopic Roux-en-Y gastric bypass surgery with an antecolic anastomosis for the treatment of morbid obesity. The hernia recurred in one of these patients, resulting in four cases. Two radiologists – experts in abdominal radiology – independently

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**Descritores:** Hérnia; Tomografia computadorizada por raios-x; Gastroplastia/métodos; Complicações pós-operatórias

**Figure 1.** The blue arrow shows the Petersen's space (GP = gastric pouch; AL = afferent loop)
reviewed the images to identify the main tomographic findings suggesting internal hernias.

The main image findings were the presence and site of abdominal distention, the herniated intestinal loop segment, the presence of mesenteric vessel rotation, and mesenteric fat haziness, the position of the Treitz angle, and the course of the ileum. Demographic (sex, age) or clinical data related to the procedure (type of surgery, type of surgical approach, intraoperative events, additional procedures, postoperative complications) and the clinical picture at the time of diagnosis were taken and correlated with the image findings. All tomography exams were performed at the same unit, according to a standardized protocol, using helical/multislice computed tomography devices. In one case a 16-row detector tomography device (Toshiba Aquilion™ 16) with 2 mm sections was used. In the other cases, a 64-row detector tomography device (Toshiba Aquilion™ 64) with 0.5 mm sections was used. Oral and intravenous non-ionic iodinated contrast was used in all exams. Petersen’s hernia was confirmed by laparoscopic surgery in all cases, followed by reduction of the herniated segment and closure of Petersen’s space (Figure 2).

**RESULTS**

Chart 1 shows that one patient was male and two patients were female; age ranged from 32 to 40 years. In all cases the hernia occurred about one year after bariatric surgery. In the case that recurred, the second hernia occurred about one year after the procedure for treating the first hernia. The predominant symptom was abdominal pain. Only one patient presented nausea and vomiting together with pain. All patients underwent videolaparoscopic Roux-en-Y gastric bypass surgery with an antecolic anastomosis. There were no significant intraoperative and immediate postoperative events.

The first tomographic imaging parameter to be evaluated was the pattern of intestinal loop distension. In all patients there was mild distension of small intestine loops in the upper abdomen; in two cases these loops were located preferentially in the left hypochondrium (Figure 3). A key finding for tomographically defining and diagnosing the herniated segment was a jejunal loop located above the stomach, which was seen in all cases (Figure 4); this finding was accompanied by mesenteric vessel

![Figure 2](image1.png)

*Figure 2. Videolaparoscopic image for Petersen’s hernia reduction. The green arrows indicate the Petersen’s space and the blue arrows, the herniated loop*

<table>
<thead>
<tr>
<th>Patients and hernia recurrence</th>
<th>Sex</th>
<th>Age</th>
<th>Time between surgery and occurrence of hernia</th>
<th>Clinical picture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient 1</td>
<td>Female</td>
<td>32</td>
<td>One year and two months</td>
<td>Abdominal pain and vomiting</td>
</tr>
<tr>
<td>Patient 2</td>
<td>Female</td>
<td>41</td>
<td>One year</td>
<td>Abdominal pain</td>
</tr>
<tr>
<td>Patient 3</td>
<td>Male</td>
<td>39</td>
<td>One year and one month</td>
<td>Abdominal pain</td>
</tr>
<tr>
<td>Recurrence</td>
<td>Male</td>
<td>40</td>
<td>One year after the first episode</td>
<td>Abdominal pain</td>
</tr>
</tbody>
</table>

![Figure 3](image2.png)

*Figure 3. Abdominal computed tomography with oral and intravenous contrast medium in the portal phase. (A) Axial image; (B) coronal reconstruction; (C) sagittal reconstruction. Gastrojejunual anastomosis (green arrow); distended herniated loop (red arrows); excluded stomach (yellow arrows)*
stretching and engorgement, which produced a “mushroom-like” aspect (Figure 5).

Mesenteric vessel rotation, described as the whirl sign or mesenteric swirl, and mesenteric fat haziness (Figure 6) were seen in all cases; in one patient there was also adjacent enlargement of peritoneal lymph nodes. A further finding was the position of the Treitz angle that, in all cases, was displaced anteriorly and to the right (Figure 7). Ileal loop positioning showed that middle and distal ileal segments had a descending trajectory in the left hypochondrium in all cases (Figure 8). The main tomographic findings in Petersen’s hernia are shown in Chart 2.
of extraluminal structures; its spatial resolution is ideal for examining the surgical bed and the anatomical alterations due to surgical manipulation. The main postoperative complications include the dumping syndrome, stenosis of the anastomosis, marginal ulcers, dehiscence, leaks and – more commonly – intestinal obstruction\(^{(11-12)}\). Obstruction is usually caused by marked intestinal loop edema in the immediate postoperative period; this usually resolves spontaneously. An iatrogenic etiology – excessive suturing – is a second cause of early obstruction. Late postoperative obstruction may be due to adhesions, fibrotic stenosis, intussusception or – more often – internal hernias\(^{(13)}\).

These may also cause volvulus and Roux loop ischemia. An early diagnosis of obstruction is essential to avoid further complications\(^{(14)}\). The incidence of internal hernias following videolaparoscopic gastric bypass surgery ranges from 1.8 to 9.7% much higher than that seen when this procedure is performed by open surgery\(^{(9)}\). Another contributing factor for internal hernias may be the creation of a potential space after marked weight loss\(^{(14-15)}\). Blachar et al.\(^{(11)}\) suggested that the transmesocolic hernia is the most common internal hernia after Roux-en-Y gastric bypass surgery; their postoperative follow-up of 463 patients revealed that 23 developed intestinal obstruction, of which 14 were due to internal hernias, 13 were transmesocolic and one was Petersen’s hernia.

Higa, Ho and Boone monitored 2,000 operated patients and found 66 cases of internal hernias, of which only five were in Petersen’s space\(^{(10)}\). Lockhart et al. reviewed the complications of 501 patients who underwent Roux-en-Y gastric bypass surgery and found 19 cases of internal hernias, of which 13 were Petersen’s hernias\(^{(16)}\). Petersen’s hernia is a specific type of internal hernia in which the intestine moves into a potential space between the caudal surface of the transverse mesocolon and the tip of the Roux loop (Petersen’s space). Although Petersen’s hernia occurs in a potential space behind the gastrojejunoanastomosis, its clinical presentation and image findings are similar to those of other internal hernias.

This follow-up showed that all cases occurred about one year after bariatric surgery. Higa, Ho and Boone\(^{(10)}\), however, showed that there is marked variability between surgery and the occurrence of internal hernias. Rapid weight loss appears to be a contributing factor for opening potential spaces through which hernias may form. Abdominal pain has been described as the main symptom of an internal hernia, as was the case in the present series; this sign may present as pain observed in postprandial mesenteric ischemia, and may or not be associated...

**DISCUSSION**

Knowledge of surgical technique and ensuing anatomical changes in the abdominal cavity, as well as possible complications is essential for investigating and diagnosing the cause of abdominal pain in patients who have undergone bariatric surgery. Postoperative image assessments may be carried out using conventional radiology or computed tomography.

Contrasted radiography makes it possible to dynamically evaluate the remaining gastric reservoir and the gastrojejunal anastomosis, verifying retention and emptying by means of oral contrast media. Multislice computed tomography adds an assessment...
with signs of upper intestinal obstruction (nausea and vomiting). There are certain image findings – published in the literature – in patients who have undergone Roux-en-Y gastric bypass bariatric surgery that strongly suggest an internal hernia; it was seen other findings in this clinical context that suggested the diagnosis of a hernia in Petersen’s space. Mesenteric vessel rotation, described as the whirl sign, together with mesenteric fat haziness, has been shown in various articles to be the most sensitive sign for the diagnosis of internal hernias^{15-16}.

These findings were evident in all patients; mesenteric lymph nodes were also more numerous, and enlarged in one case. Distended intestinal loops in the left hypochondrium presenting a mushroom shape and mesenteric vessel elongation^{15-16} are a consequence of vascular engorgement and mesenteric fat haziness; in a coronal reconstruction, with herniated loops in the upper pole, these findings have a mushroom-like appearance. Lockhart et al.^{16} also described this finding, which increases the diagnostic specificity; it can be seen in two of our cases. It was also noted that the small bowel loop that is herniated in Petersen’s hernia is a jejunal loop segment which becomes located above the gastric level. Signs of intestinal obstruction have often been described in the radiological literature, including signs of internal hernias^{12,14-17}.

An abdominal distension is located preferentially in the upper abdomen, tending towards the left hypochondrium. It was observed that the middle/distal ileum courses downwards in the left hypochondrium, and has a habitual horizontal path up to the cecum. Displacement of the Tritz angle, crossing anteriorly towards the right, was clearly demonstrated in these patients. Although our tomographic findings agreed with most published cases, this study was limited by the small sample. The power of this study is also lower, since there was no comparison group consisting of patients with other types of postoperative hernias occurring in bariatric surgery. Some signs, such as distended intestinal loops, the whirl sign and the mushroom-like appearance are common to other types of internal hernias. A precise diagnosis of Petersen’s hernia requires specifically finding and locating the herniated intestinal segment. However, the present study has a didactic purpose to clearly illustrate the computed tomographic findings in this type of hernia, with surgical proof.

**CONCLUSIONS**

With the growing number of indications of surgery for treating morbid obesity, imaging assessments have become indispensable tools in the diagnosis of complications. Internal hernias, including Petersen’s hernia, generally manifest in the late postoperative period and may have a non-specific presentation. The set of imaging findings in computed tomography of patients with Petersen’s hernia, amply discussed in this study, is a spectrum of highly suggestive changes for diagnosis of this condition.

**ACKNOWLEDGMENTS**

To the radiologist Dr. Diogo Lago Pinheiro for his relevant contribution to the present study.

**REFERENCES**
