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Lemniscate intestinal loop through an internal hernia after Roux-en-Y gastric bypass cause of coecum mobile. A case report

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The internal hernia is a typical complication after laparoscopic Roux-en-Y gastric bypass surgery. In most cases, there are chronic symptoms that only lead to a diagnostic laparoscopy during the diagnostic exclusion procedure. Less common is acute internal hernia with devastating pain, ileus symptoms and even the development of intestinal gangrene. Although this case describes a typical constellation, it posed a particular challenge because it resulted in mesenteric lemniscate-like torsion through the Petersen pouch.

Case presentation. A 29-year-old patient presented to our emergency department with abdominal pain, complained of sudden epigastric pain that lasted overnight, and radiated into the back with a permanent belching every 10 seconds. Four weeks ago, the patient received an abdominoplasty, complaining of postprandial nausea, meterorism and constipation afterwards. 19 months ago, a Roux-en-Y gastric bypass with a weight of 109 kg and a body mass index of 42.6 kg/m^2 was done. The current body weight was 60 kg and the body mass index was 23.4 kg/m^2. After focused assessment with sonography for trauma and the detection of dilated intestinal loops, an abdominal computer tomography (CT) was performed. Radiologically, the suspicion of mesenteric malrotation was confirmed. The SWELL (CT-graphic swirl sign, excess weight loss > 95 %, liquid in abdomen CT scan) score was positive with a CT-graphic swirl sign and an excess weight loss of 108.9 % (> 95 %), no chylus or ascites. We discussed an immediate, necessary diagnostic laparoscopy. Based on the ileocoecalpol, it was not possible to establish a proper assignment of the detached gastrointestinal tract. The exploration of the sigmoid colon as the only fixed point revealed that this was a complete fixed twisting of the right intestinal part with a twist of the caecum into the right upper abdomen through the Petersen space. This necessitated a laparotomy to manually cancel Bernoulli's lemniscate-like loop and perform a mesenteric defect suture of the mesenteric space of Brolin and the Petersen space with a non-absorbable suture. The intestinal loops and patient recovered quickly. The dismission was on the 4th post-operative day.

Conclusions. The internal hernia after gastric bypass remains a diagnostic challenge despite advances in imaging. Due to the increasing number of patients undergoing bariatric surgery, this differential diagnosis must always be considered in the case of abdominal complaints. In addition to the excess weight loss of > 95 %, this case shows that a recent abdominoplasty can also provoke an internal hernia.

Keywords

internal hernia, Roux-en-Y gastric bypass, adipositas, bariatric surgery, mesenteric defect, mesenterial closure, Petersen pouch, Brolin pouch, coecum mobile, Lemniscate, Bernoulli.

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The proximal Roux-en-Y gastric bypass was first performed in 1966 by Edward E. Mason and Chikashi Ito, inspired by weight loss after gastrectomies [28]. Over the years, this process has been modified. One change that formed the basis for the procedure carried out today was the modification in 1991, according to Wittgrove and Clark [44]. He postulated the laparoscopic implementation and formation of a small gastric pouch. Nowadays, there are various techniques and variants that affect the essential components of this procedure and the rate of development of an internal hernia [19]. In eighth registry report of 2023 of International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO), with 24 participating countries and a total of 480,970 bariatric registered procedures, Roux-en-Y surgery for obesity continues to account for 30 % of all bariatric surgeries performed worldwide, making it the second most common procedure after sleeve gastrectomy [21]. As a rule, an antecolic alimentary and a biliopancreatic loop are formed, which pass into the common channel via a footpoint anastomosis [42].

The internal hernia is defined by a passage from an intestinal loop through a hernia gap or space, the so-called Petersen space formed by the antecolic alimentary loop and transverse colon and mesenteric Brolin space by jejunojejunostomy [22, 34]. It continues to be a typical early and long-term complication after laparoscopic Roux-en-Y gastric bypass surgery. A recent multicenter study from 2023, which evaluated data from 46,918 patients from 2005 to 2015 from the New York SPARCS (Statewide Planning and Research Cooperative System) database, was able to determine a cumulative internal hernia rate of 4.8 % within 3 years. The cumulative rate at the end of the thirteenth year was 12 %. In the end, however, a declining incidence could also be found in the course of the last few years of the study [11]. A large Norwegian cohort study was able to work out a rate of 11 % within 5 years [1]. If there is a preoperative history of smoking, the hazard ratio of 2.3 is significantly higher than for nonsmokers [6].

The clinical symptoms of an internal hernia can vary greatly [9, 42]. Asymptomatic, intermittent, and chronic subacute symptoms make diagnosis and suspected diagnosis even more difficult.

In most cases, there are chronic symptoms that only ultimately lead to a diagnostic laparoscopy in the diagnostic exclusion procedure. Here, postprandial symptoms and colicky pain often occur early. These move into the left upper abdomen and can then also be accompanied by regurgitation and vomiting, usually clear fluid [23]. It is not uncommon for patients to report that, depending on their position in the lying position, the symptoms are decreasing. In many cases, these are transient and can progress to an acute stage with sometimes devastating pain, with the manifestation of ileus symptoms up to the development of intestinal gangrene and peritonitis.

There are various attempts to classify the internal hernia. They are based on the time of the first operation, early or late onset of the symptoms and time of consecutive surgery, extent of the obstruction, anatomical pathways through the mesenteric defects and affected loops alimentary, biliopancreatic and common channel in the sense of the ABC classification (A — alimentary, B — biliopancreatic, C — common channel) [7, 13, 18, 29]

Computed tomography has a sensitivity of 63—92 % and is therefore the most important imaging diagnosis [2, 45]

The so-called mesenteric swirl is the most specific sign and is easy to see when quickly scrolling the individual axial but also not negligible sagittal computer tomography (CT) images [20, 27].

If both the swirl sign and the so-called mushroom sign occur [38], which is created by a mushroom-shaped configuration through hernated small intestine loops with pneumatic stool contents, the sensitivity and specificity can be slightly increased [27]. Chylous ascites, enlarged mesenteric lymph nodes, mesenteric edema and venous congestion with the development of splenomegaly can be indirect signs of chronic recurrent torsion with twisting and obstruction of the mesenteric vessels [4]. Other signs may include the hurricane eye sign, the small bowel behind the superior mesenteric artery, and right-sided anastomosis [10].

However, if acute ileus signs or small intestinal obstruction are missing, diagnosis by CT is more difficult and does not seem to be suitable for the clarification of intermittent complaints or internal hernias, so only an exclusion laparoscopy is useful in order to avoid fatal complications [20]. Valid predictive scores for an internal hernia result from a CT-graphic swirl sign (SWirl), excess weight loss > 95 %, and detection of ascites (free Liquid), the so-called SWELL (SWirl, excess weight loss > 95 %, liquid in abdomen CT scan) score [15]. In consideration of 5 further clinical signs — the U- or C-shaped loop, beak sign, and fat notch sign — and two clinical signs of neutrophilia and abdominal tenderness, the rate of negative laparoscopies can be significantly reduced and the need for laparoscopy is given [15, 26].

The surgical treatment of the internal hernia continues to be a challenge and is associated with considerable risks [3, 30]. In-hospital treatment

pathways and surgical standards help avoid typical pitfalls [23]. In our clinic, an anti-Trendelenburg position is performed with spread legs for the surgeon and a slightly retracted upper body with legs bent in the beach chair position. If an internal hernia is suspected, both arms are attached in order to explore the small intestinal loops starting from the ileocoecal pole. In our clinic, the capnoperitoneum is created through the Veress needle via Palmers Point. This is because massive weight loss with melted visceral fat and a condition after an abdominoplasty are not uncommon. Then a 12 mm trocar is placed in the left upper abdomen for instrument change and tobacco pouch suture with a camera-guided atraumatic optic trocar. Another 10 mm trocar is placed in the middle abdomen supraumbilically, and a 5 mm trocar in the right upper abdomen and left upper abdomen. The incision at Palmers Point is used by another 5 mm trocar. These positions allow a change of position, confirmation of the diagnosis, retorsion of the intestine and closure of the mesenteric defects. For closure, a continuous slowly absorbable suture is now used in our clinic. Lesions of the small intestine during instrumental exploration, fixed intestinal loops due to the hernia gaps, contact vulnerability, lack of capnoperitoneum possibility and reliable overview of dilated small intestine loops make conversion necessary in some cases [23, 29].

Case presentation

Patient information

A 29-year-old patient presented with devastating abdominal pain in our emergency room. She complained of sudden epigastric pain that lasted overnight, radiated into the back and had been permanent since the morning hours. It was noticeable that the patient showed a permanent belching of air every 10 seconds. She reported that she had had problems with bowel movements since an abdominoplasty a month ago and repeatedly suffered from severe meteorism and belching, especially postprandial. In the surgical history, there was a condition after laparoscopic proximal Roux-en-Y gastric bypass surgery with an initial weight of 109 kg, which corresponded to a body mass index (BMI) of 42.6 kg/m^2 with a height of 160 cm. At that time, the patient already had arterial hypertension, urinary incontinence and hirsutism as obesity-associated comorbidities. During the last pregnancy, the patient developed insulin-dependent gestational diabetes. The primary surgery was performed 19 months ago as a laparoscopic placement of a proximal gastric bypass according to Roux-en-Y with a 100 cm alimentary channel and 100 cm biliodigestive channel, an antecolic antegastric with a 60 mm side-to-side jejunojejunostomy and a 30 mm linear gastrojejunostomy stapleranastomosis. A suture for mesenteric defects was not used as the clinic's own standard.

The adminoplasty 4 weeks ago was performed at a weight of 60 kg and a BMI of 23.4 kg/m^2. The weight loss was 45 % and the excess weight loss was 108.9 %.

Physical examination

The abdomen was peritonitically tense in the clinical examination and could hardly be examined. Under parenteral Novalgin and Dipidolor infusion, a soft lower abdomen was now present, but still peritonitically tense upper abdomen. Auscultatory, no peristalsis or elevated bowel sounds could be heard.

Diagnostic

The focused assessment with sonography for trauma showed partially dilated intestinal loops. Laboratory-chemically, no leukocytosis, no C-reactiv protein and lactatdehydrogenase elevation were shown, the creatinkinase and electrolytes were normal. Thrombocytosis with 392 platelets/nl (normal value: 140—360/nl), a slight glutamat-pyruvat-transaminase/alanin-aminotranferase increase of 38 U/L (norm 10—35 U/L) and a lipase increase of 77 U/L (norm $<$60 U/L) were conspicuous, the cholestasis parameters, renal retention parameters and coagulation were within the normal range. An abdominal CT was performed if an internal hernia was suspected.

Radiologically, the suspicion of a mesenteric malrotation with venous outflow disorder in the sense of a volvulus was confirmed (Fig. 1—3). In previous gastric bypass surgery, an internal hernia was considered a differential diagnosis without evidence of a hollow organ perforation. A swirl sign and a beak sign were depicted. Ascites as the third parameter of the SWELL score could not be documented. A massive edematous mesenteric root with congested vessels filling the entire ventrodorsal space of the abdomen was striking.

Therapy

We discussed an immediate, necessary diagnostic laparoscopy. Intraoperatively, the finding of an internal hernia was confirmed (Fig. 4, 5). The intestinal loops were extremely vulnerable to contact, the mesentery was edematously bloated with partial fibrinous sweating, and the venous vessels were congested. Portions of the alimentary channel were already purple in color. As a rule, exploration of the small intestine in internal hernia is carried out

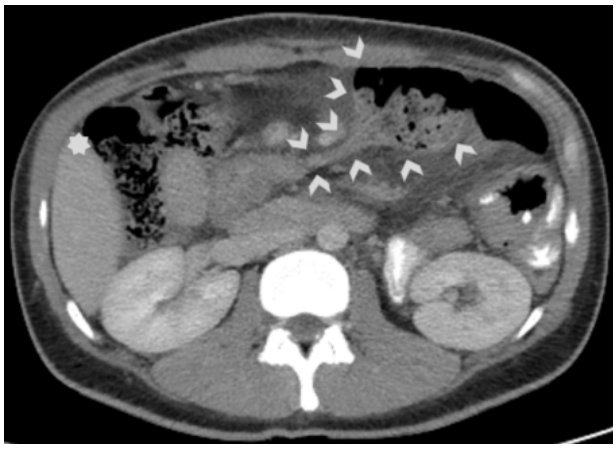

Figure 1. **Abdominal computer tomography. The arrows mark the left transverse colon, which tapers behind the mesenteric root (distended colon = head, narrowed colon = beak of the bird), the asterisk marks the torqued coecum mobile in the right upper abdomen**

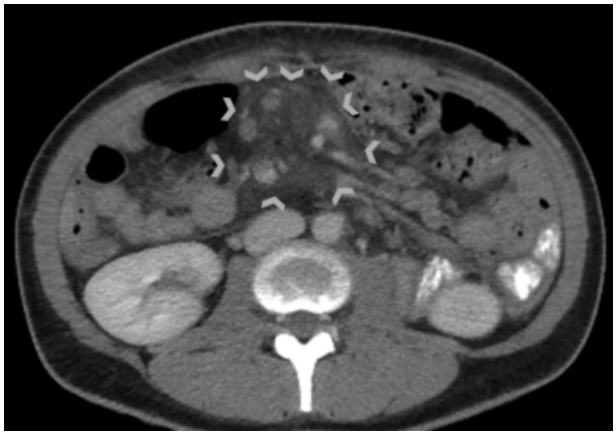

Figure 2. **The arrows mark the massively edematous torqueted mesenteric root, which occupies the entire abdominal space**

from the ileocoecalpole, but here an unusual picture emerged. The appendix was on the «wrong» side facing away and the coecum was relatively high in the right upper abdomen. The exploration of the typical gaps was impossible due to the massive swelling and fixed parts of the intestine that could not be repositioned. Only an exploration of the sigmoid colon revealed that this was a complete twisting of the common channel, ileococal area with attached right hemicolon and middle transverse through the Petersen space, as the left transverse colon suddenly dived towards Treitz and no longer continued towards the liver. The right hemicolon seemed to embrace the alimentary channel, which also passed proportionately through the mesenteric defect. It gave the impression that someone took the ileocaecal pole with the common channel, guided it through the Petersen pouch, took parts of the alimentary channel

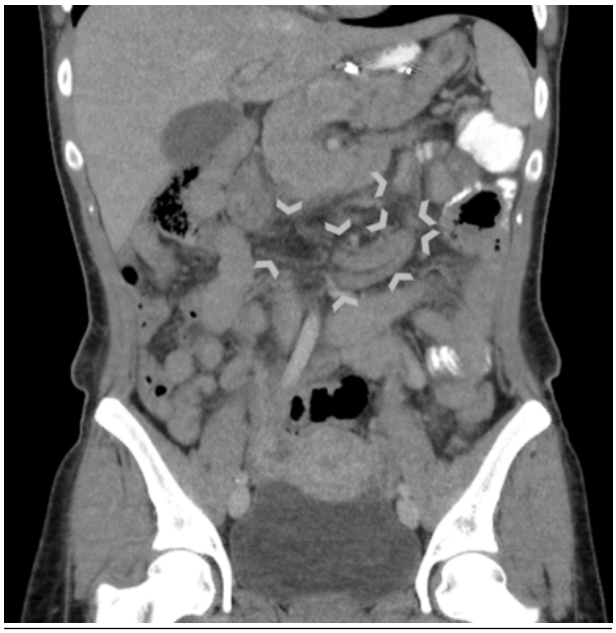

Figure 3. **Swirl sign and congested mesenteric vessels. The arrows indicate the mesenteric twist, when scrolling through the CT images, the swirl sign becomes clearer**

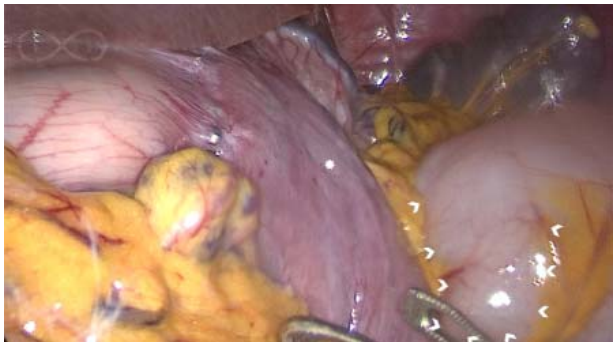

Figure 4. **The forceps mark the ischemic livid twisted alimentary loop, the arrows mark the submersible left transverse colon behind the mesenteric root with the formation of the typical beak sign**

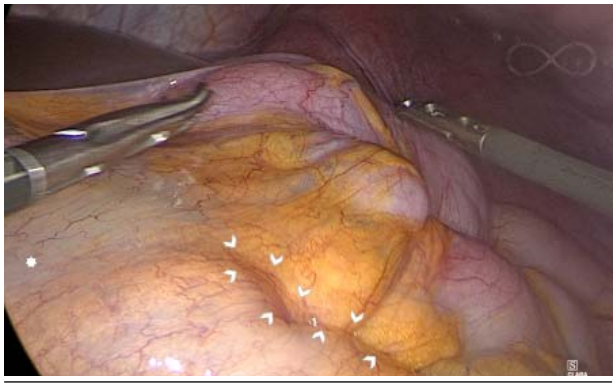

Figure 5. **The asterisk marks the mesenteric edema, the arrows mark the mesocolic lemniscate-like twist through the Petersen gap with narrowing of the «natural» passage of the left hemicolon retrograde of the alimentary loop, which is enclosed by the right hemicolon and common channel**

with it and put it over the right flexure in front of the mesentery of the transverse colon and right hemicolon, so that the coecum came to rest in the right upper abdomen in a correspondingly twisted manner. This necessitated a laparotomy to manually cancel the lemniscate-like loop and perform a closure of the mesenteric defect of Brolin and the Petersen pouch with a non-absorbable tobacco pouch suture. The intestinal loops recovered quickly. The postoperative course was without complications. The patient was able to leave the clinic on the 4th post-operative day with a proper diet build-up and well-being.

Discussion

The caecum mobile refers to a fixation anomaly with a misalignment of the coecum. The normal position of the caecum is the result of rotation, mesenteric fixation, and descensus due to growth in early childhood. In the absence of growth, the cecal pole can be located in a cranial direction, both ventrally or dorsally, as well as medially or laterally. If longer sections are insufficiently retroperitoneally fixed, a coecum mobile or an ascending mobile colon develops, which can ultimately lead to volvulus.

The term «volvulus» comes from the Latin volvere, which means «to turn». This condition has been described for thousands of years, as have rudimentary therapies. The first written documentation and therapy recommendation of the volvulus with the full picture of the acute abdomen was discovered in the Ebers Papyrus, an almost 19-metre-long, over 3600-year-old papyrus scroll from the 16th century BC, which the egyptologist Georg Ebers acquired in Luxor in 1873 and brought to Leipzig. It is the only completely surviving medical manuscript of antiquity (Eb 296 (52, 1—51, 7)) and describes the suffering of a patient with an intestinal obstruction caused by a worm-like twisting of the intestine [37].

The incidence of colonic volvulus varies considerably around the world. In Western Europe and the USA, only about 5 % or less suffer from it. In the so-called «volvulus belt» (Middle East, Africa, the Indian subcontinent, Turkey, and South America), volvulus is the cause of intestinal obstruction in up to 75 % of cases [12, 16, 32]. Coecum mobile is usually asymptomatic and is described in autopsies in 11 % of cases [35, 41]. The occurrence of a mobile colon, including the transverse, is much rarer. Coecumvolvulus is responsible for about 1.0—1.5 % of intestinal obstructions and about 10—40 % of all colonic volvulus cases and thus occurs significantly less than sigmoid volvulus [33]. The coecum volvulus can be divided into an axial ileocoelic volvulus (90 % of cases) and an upturned coecum volvulus (10 % of cases, «cecal bascule»). In the case of the patient, there was also a lack of suspension of the transverse colon. This congenital anomaly is very rare and is similar to Chilaiditi syndrome [5, 31].

The therapy of the coecum mobile and colon ascendens was discussed in detail as early as 1908 [8, 43]. Numerous cases were reported by the German surgeon Prof. Wilms, who worked at the University Hospital Basel, and processed by means of radiograms [43]. Various methods up to a cirrharmonica-like gathering with non-absorbable sutures of the caecum and colon ascendens have been described as early as the early 20th century [14]. A conservative treatment of volvulus was already described by Hippocrates [5]. He recommended blowing air into the intestine and inserting a 10-finger-long suppository. Endoscopic treatment is not expedient, as the length of the colon and the closed abdominal wall prevent the intestine from straightening. Thus, only surgical therapy such as coecopexy, hemicolectomy, coecostoma and colostomy can be considered. In the present case, however, it was not the mobile hemicolon that was the cause of the disease, but rather the Petersen pouch after proximal Roux-en-Y gastric bypass. The question of whether or not to have a primary mesenteric defect closure seems to have been clarified in bariatric surgery. Many retrospective analyses and prospective registry data indicate that the probability of developing an internal hernia in the course of life is so high that the respective authors recommend a defect closure of both the mesenteric gap of the jejunojejunostomy, so-called Brolin gap, and the gap between the raised alimentary jejunal loop, Treitz's ligament and transverse colon, so-called Petersen pouch after laparoscopic Roux-en-Y gastric bypass surgery. The assumption is based on the analysis of retrospectively and prospectively evaluated patient data sets [25, 40]. However, if one takes into account the complete scientific evidence, this contrasts with a meta-analysis from 2020, which determines a low incidence but documents an increased number of small bowel obstructions that cannot be attributed to an internal hernia [17]. Two other prospectively randomized studies found no difference between the primary closure and non-closure groups in the three-year and five-year follow-ups [36, 39]. Likewise, all studies show prolonged surgical time and a higher instant postoperative complication rate due to the mesenteric defect closure [24, 40].

So, the truth seems to lie in the middle. One study finds smoking to be an independent factor in the development of an internal hernia, while other studies suggest a higher incidence in pregnant women, which can be explained by the change in the spatial

conditions of the intestinal loops and growing uterus in the abdomen. Expert opinions recommend not doing any sports or strenuous activities for three months after surgery in order to avoid increased abdominal pressure and thus the formation of an internal hernia. Others recommend the regular cutting of the omentum majus in order to use this as a space seal.

Each centre should therefore go its own way. A first step would be to avoid a Roux-en-Y gastric bypass; a second step would be to check the surgical technique; and a third step would be to perform defect closure in high-risk patients such as smokers and young women who want to have children. The fourth step would be the choice of suture material and seam technique for the defect closure. A recommendation as to which closure technique should be chosen continuously — single button sutures, tobacco pouch sutures, absorbable, non-absorbable sutures, or clips — cannot be answered by the current state of studies. In our case, we chose a non-absorbable tobacco pouch suture to close the Petersen and Brolin gaps. A hernia recurrence has not occurred so far.

Conclusions

The detection of an internal hernia continues to be a challenge. It also helps to develop an internal standard and recommendations for action in patients with abdominal complaints after proximal Roux-en-Y gastric bypass. In diagnostic imaging, CT examination continues to be the most sensitive means of detecting an internal hernia. In this case, it is advisable to discuss the images with the radiologists, point out the typical signs, and review them retrospectively again after revision surgery.

Due to the formation of centers and sometimes complex course of the internal hernia, it is not uncommon (40—52 %) for false negative findings to be described in CT scans [3]. Therefore, the attending surgeon should not hesitate to strive for a diagnostic laparoscopy, according to the law of the Rhenish saying «Isch hab' da so ein Jefühl» («I have such a feeling»).

Declaration of interests

The authors declare that they have no conflicts of interest and that they have no financial ties to disclose.

Ethics approval and written informed consent statements

Oral and written informed consent was obtained from the patient to publish the patient-related data in anonymized form.

Authors contributions

C. R. D. Demtröder, T. H. Le, P. Kirchmeyer, D. Utz: surgery, treatment, literature research, literature review and draft of the manuscript; H. Agarius, U. Giger-Pabst, D. Dajchin: literature research, literature evaluation and critical revision of important contents of the manuscript.

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Внутрішня грижа з лемніскатоподібним перекрутом брижі після шунтування шлунка за Ру. Клінічний випадок

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Внутрішня грижа є типовим ускладненням після лапароскопічного шунтування шлунка за Ру. У більшості випадків є хронічні симптоми, які є підставою для проведення лапароскопії лише для заперечення діагнозу. Рідше трапляється гостра внутрішня грижа із виразним больовим синдромом, симптомами кишкової непрохідності та навіть розвитком гангрени кишечника. Описаний випадок був особливим викликом, оскільки призвів до лемніскатоподібного (вісімкоподібного) перекруту брижі крізь простір Петерсена, хоча перебіг був типовим.

Опис клінічного випадку. Пацієнтка, 29 років, поступила у відділення невідкладної допомоги зі скаргами на раптовий біль в епігастрії протягом ночі з іррадіацією в спину, що супроводжувався регургітаці-

єю кожні 10 с. Чотири тижні тому пацієнтка перенесла абдомінопластику. Після оперативного втручання скаржилася на нудоту після вживання їжі, метеоризм і запори. Відомо, що 19 міс тому пацієнтці з масою тіла 109 кг та індексом маси тіла 42,6 кг/м^2 було виконано шунтування шлунка за Ру. Поточна маса тіла — 60 кг, індекс маси тіла — 23,4 кг/м^2. Після проведення FAST-сонографії та виявлення розширення петель кишечника було виконано комп'ютерну томографію черевної порожнини. Рентгенологічно підтверджено підозру щодо мезентеріальної мальротації. Оцінка за шкалою SWELL була позитивною з КТ-ознакою завихрення, надлишкова втрата маси тіла становила 108,9 % (> 95 %), без хілусу й асциту. Прийнято рішення про негайне проведення діагностичної лапароскопії. На підставі ілеоцекальпоскопії не вдалося встановити правильної локалізації відриву шлунково-кишкового тракту. Дослідження сигмоподібної кишки як єдиної фіксованої точки показало, що це був повний фіксований заворот правої частини кишки із заворотом сліпої кишки в праву верхню частину живота крізь простір Петерсена. Це зумовило необхідність проведення лапаротомії для ручного усунення лемніскатоподібної петлі Бернуллі та ушивання дефекту брижі мезентеріального простору Броліна та простору Петерсена шовним матеріалом, що не розсмоктується. Пацієнтка швидко відновилася та була виписана на 4-ту добу після операції.

Висновки. Внутрішня грижа після шунтування шлунка є діагностич
ною проблемою попри досягнення в галузі візуалізаційних методів діагностики. У зв'язку зі збільшенням кількості пацієнтів, які потребують баріатричного хірургічного лікування, цей диференційний діагноз завжди слід установлювати за наявності абдомінальних скарг. Крім втрати надлишкової маси тіла (> 95 %), цей випадок показує, що нещодавнє проведення абдомінопластики також може спричинити внутрішню грижу.

Ключові слова: внутрішня грижа, шунтування шлунка за Ру, ожиріння, баріатрична хірургія, дефект брижі, закриття брижі, простір Петерсена, простір Броліна, coecum mobile, Лемніската Бернуллі.

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