Twists and turns in the body: an imaging spectrum

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Life is full of twists and turns. These surprises can sometimes be wonderfully invigorating. Twists and turns can also occur in the body, however, sometimes with dangerous consequences. Torsion and volvulus are important causes of acute abdominal pain. The clinical symptoms and signs associated with torsion and volvulus are often non-specific and are difficult to diagnose clinically. Clinicians frequently rely on imaging methods to make the diagnosis. Prompt and accurate diagnosis is important to avoid the life-threatening complications of torsion and volvulus. Therefore, it is helpful to be familiar with the features of torsion and volvulus.

Introduction

Torsion and volvulus often pose challenges for clinicians due to the non-specific symptoms and signs. Since these conditions are difficult to diagnose clinically, clinicians often rely on imaging methods to make the diagnosis. Prompt and accurate diagnosis is important to avoid the life-threatening complications of torsion and volvulus. In this article, the relevant clinical features and common radiological features of some conditions of torsion and volvulus are discussed.

Gastric volvulus

Gastric volvulus occurs when there is an abnormal rotation of the stomach.[1] It is a surgical emergency that requires prompt diagnosis and treatment. Gastric volvulus occurs most commonly in elderly people.[2] The condition is usually divided into three subtypes based on the type of rotation: organoaxial, mesenteroaxial, and a mixture of organoaxial and mesenteroaxial.

In organoaxial volvulus, the stomach rotates along its long axis, which is a line drawn between the cardia and the pylorus, with the greater curvature being displaced superiorly and the lesser curvature located more caudally in the abdomen. In mesenteroaxial volvulus, the stomach rotates on an axis perpendicular to the long axis of the stomach along a line joining the middle of the lesser curvature to the greater curvature, with resultant displacement of the antrum above the gastroesophageal junction. Organoaxial volvulus is the most common type and accounts for approximately two thirds of incidence of gastric volvulus.[3]

Causes of gastric volvulus include congenital abnormalities such as lengthening of the gastrohepatic omentum and gastrocolic ligament, and weakness of the gastrophrenic ligament.[1] The condition is usually associated with a large sliding or para-oesophageal hiatus hernia.[2] Other predisposing factors include phrenic nerve palsy, eventration of the diaphragm, and traumatic diaphragmatic hernia.[2]

The severity of symptoms depends on the direction and degree of rotation.[1] Based on the clinical features, gastric volvulus can be classified as acute or chronic recurrent.[1] Acute symptoms tend to occur when the rotation is at or beyond 180°. The clinical presentation of acute gastric volvulus includes violent retching with little vomitus produced, severe epigastric pain, and difficulty in passing a nasogastric tube, also known as the Borchardt triad.[2] The clinical presentation of chronic recurrent volvulus includes intervals of dyspeptic pain.[1]

Radiographic findings from plain radiographs may include intrathoracic air, indicating herniation of a portion of the stomach above the diaphragm.[3] On barium study, the stomach may be inverted, with the greater curvature above the lesser curvature or the pylorus above the cardia (Fig 1a, 1b).[2] Barium studies may also evaluate the passage of ingested oral contrast material into the duodenum.[3] Computed tomography (CT) may help confirm rotation of the herniated stomach (Fig 1c).[3] Differential diagnoses based on imaging features include hiatus hernia, postoperative changes as for oesophagectomy with gastric pull through, and epiphrenic diverticulum.

Key words
Diagnostic imaging; Intestinal volvulus; Stomach volvulus; Torsion abnormality; Uterine diseases

Hong Kong Med J 2010;16:390-6

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Gastric volvulus may cause gastric outlet obstruction and eventually compromise the blood supply to the stomach leading to gangrene and perforation.[1,2] These complications can be detected by CT. Gastric volvulus has a mortality of 30 to 50% due to gastric ischaemia with secondary necrosis, perforation, and shock.[4] Treatment of gastric volvulus includes decompression of the stomach, reduction of the volvulus, and correction of the underlying cause with or without fixation of the stomach.[4]

身體裡出現的三彎九轉：應用成像術診斷

人生總是迂迴曲折，三彎九轉有時候使我們精神振奮。三彎九轉也會在我們的身體出現，但有時卻可能危及生命，後果堪虞。器官扭轉和扭結是造成急性腹痛的主要原因，但發生時並沒有特別明確的臨床徵狀，很難斷症，所以醫生須經常靠成像術來診斷。及時準確的診斷，對避免因器官扭轉和扭結引發致命的併發症非常重要，正因為此，醫生須充份掌握器官扭轉和扭結的特點。

Volvulus complicating transmesenteric hernia

Internal hernia is a rare condition, occurring in 0.5 to 4.1% of patients with intestinal obstruction. Transmesenteric hernia accounts for less than 8% of internal hernia.[5] About 35% of transmesenteric hernias occur during childhood and may be related to congenital mesenteric defects.[5] In adults, most mesenteric defects are related to surgery, trauma, or inflammation.[5] The incidence of transmesenteric hernias is increasing, which may be related to the increased frequency of surgical procedures in which a Roux-en-Y loop is constructed that may predispose a patient to development of an internal hernia.[6] A volvulus may complicate transmesenteric hernia and cause hernial strangulation and intestinal gangrene. The clinical presentation often includes signs and symptoms of acute small bowel obstruction.[7]

As a mesenteric defect is not well visualised, observation of clustering of small bowel loops and abnormalities of the mesenteric vessels seen by CT is important for the diagnosis of transmesenteric hernia complicated by volvulus.[5] Computed tomographic features of abnormalities of the mesenteric vessels include an engorged and stretched mesenteric vascular pedicle and converging mesenteric vessels located at the entrance of the hernial sac (Fig 2).[5] Other CT features include medial displacement of the descending colon, dilated small bowel, and presence of a transition point between dilated and non-dilated small bowel.[6] A differential diagnosis to consider based on the imaging features is closed loop obstruction. Volvulus complicating transmesenteric hernia could result in bowel gangrene and perforation, which could be detected by CT.

Sigmoid volvulus

The sigmoid colon is the most common site of colonic volvulus and accounts for 60 to 75% of all patients with colonic volvulus.[3] The aetiology of sigmoid volvulus remains uncertain, but includes chronic constipation, a high-fibre diet, and sigmoid colon redundancy.[3,8] The clinical presentation includes non-specific abdominal pain and symptoms of bowel obstruction.[3,9]

Radiographic findings include a large air-filled sigmoid colon with a coffee bean–like shape, arising

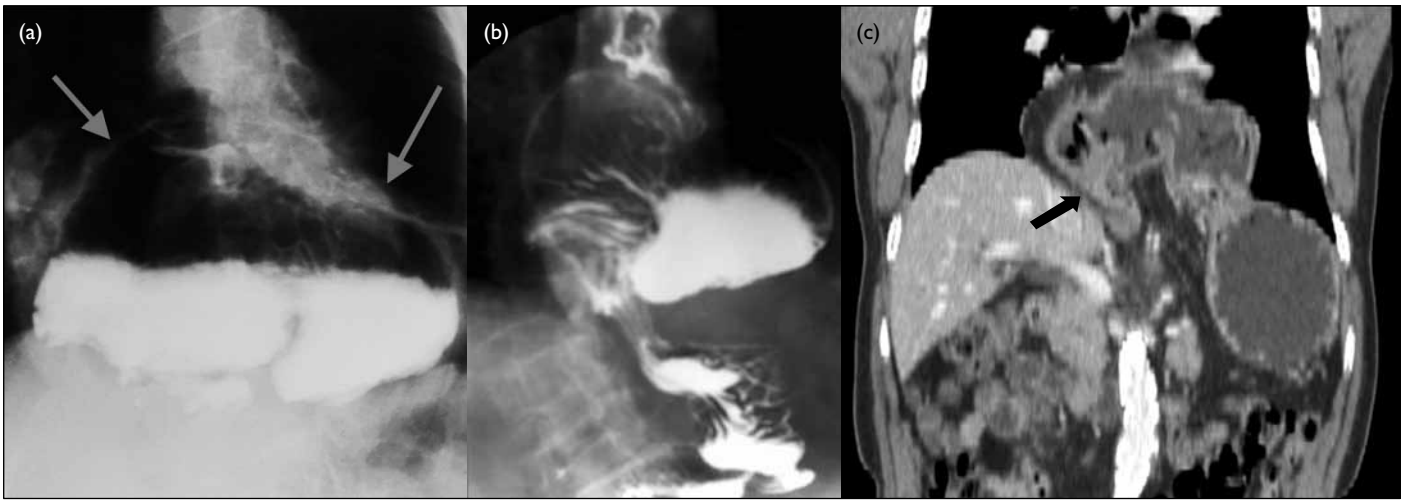

FIG 1. Organoaxial volvulus

(a) Barium meal image showing upward rotation of the stomach along its long axis, resulting in inversion of the greater curvature (arrows) above the lesser curvature. (b) Barium meal image showing herniation of a large portion of the stomach above the diaphragm, compatible with hiatus hernia. (c) Coronal computed tomographic image of the abdomen showing hiatus hernia and transverse lie of the stomach. The arrow shows the pylorus

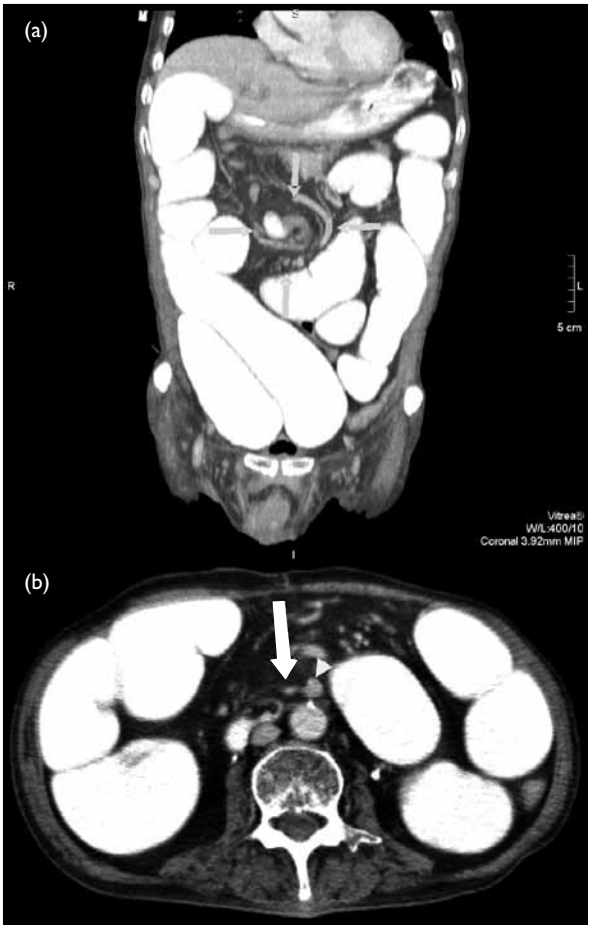

FIG 2. Transmesenteric hernia complicated by volvulus
(a) Coronal computed tomographic image of the abdomen and pelvis showing dilated small bowel loops. Crowded, converging, and twisted vessels are seen at the hernial orifice (arrows), with a whirl pattern characteristic of torsion. (b) Axial computed tomographic image through the abdomen showing an abnormal relationship between the superior mesenteric artery (arrow) and superior mesenteric vein (arrowhead)

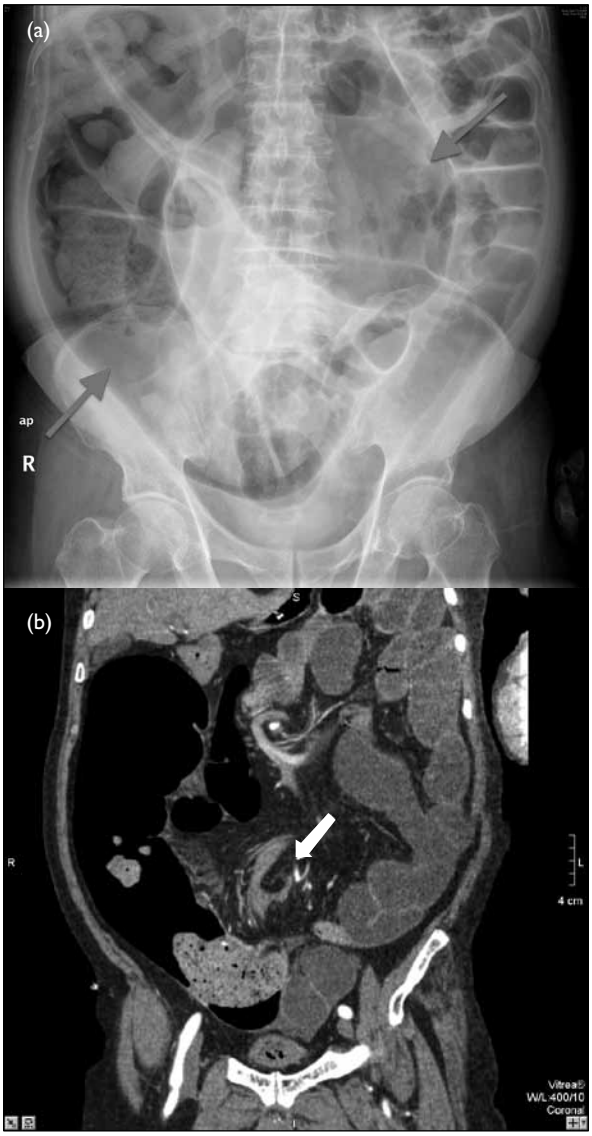

FIG 3. Sigmoid volvulus
(a) Abdominal radiograph showing a large air-filled bowel loop (arrows) arising from the pelvis and extending cranially, representing the sigmoid colon, with a coffee bean–like shape. (b) Coronal computed tomographic image showing whirling of the sigmoid mesocolon (arrow)

from the pelvis and extending cranially beyond the level of the transverse colon (Fig 3a). Computed tomographic features include abnormal position of the sigmoid colon and whirling of the mesentery at the level of the volvulus (Fig 3b).[3] Differential diagnoses based on imaging features include acute ileus, toxic megacolon, and distal colon obstruction.

The prognosis of sigmoid volvulus depends on the disease stage, timing of surgery, and co-morbidities. Complications of sigmoid volvulus include bowel gangrene and perforation. The highest mortality rate is for patients with clinical signs and symptoms of peritonitis.[9] Imaging methods, such as CT, could help with earlier diagnosis, resulting in earlier management of sigmoid volvulus. Management of sigmoid volvulus involves relief of obstruction by a non-operative method via endoscopy for viable volvulus.[8] For patients with failed decompression and intestinal ischaemia and perforation, resection and anastomosis may be considered.[8]

Caecal volvulus

Caecal volvulus is a rotational twist of the right colon on its axis.[10] Caecal volvulus accounts for 25 to 40% of colonic volvulus. The causes of caecal volvulus include congenital defect in the attachment of the right colon, postpartum ligamentous laxity and a mobile caecum, chronic constipation, and laxative use.[10]

Radiographic features include a dilated gas-filled viscus in the left upper quadrant or mid abdomen.[3] Caecal volvulus could be diagnosed by

contrast enema study or CT. In contrast enema study, there is usually a beak-like tapering at the level of the volvulus, and usually only a small amount of contrast material is able to pass beyond the volvulus.[3] At CT, the twisted mesentery and the abnormally positioned caecum at the left upper/mid-abdomen can be demonstrated.[10]

Caecal volvulus may lead to bowel ischaemia and perforation, depending on the duration of symptoms. These complications can be detected by CT. Differential diagnoses based on imaging features include sigmoid volvulus, acute ileus, and distal colon obstruction.

Transverse colon volvulus

Transverse colon volvulus is rare, accounting for 5 to 10% of colonic volvulus. Contrast enema study can show the characteristic beak-like tapering of the colon at the level of the volvulus.[3] As transverse colon volvulus is rare and therefore unexpected, this condition is usually diagnosed by CT. Diagnostic features on CT include features of bowel obstruction and mesenteric twist at the level of the volvulus.

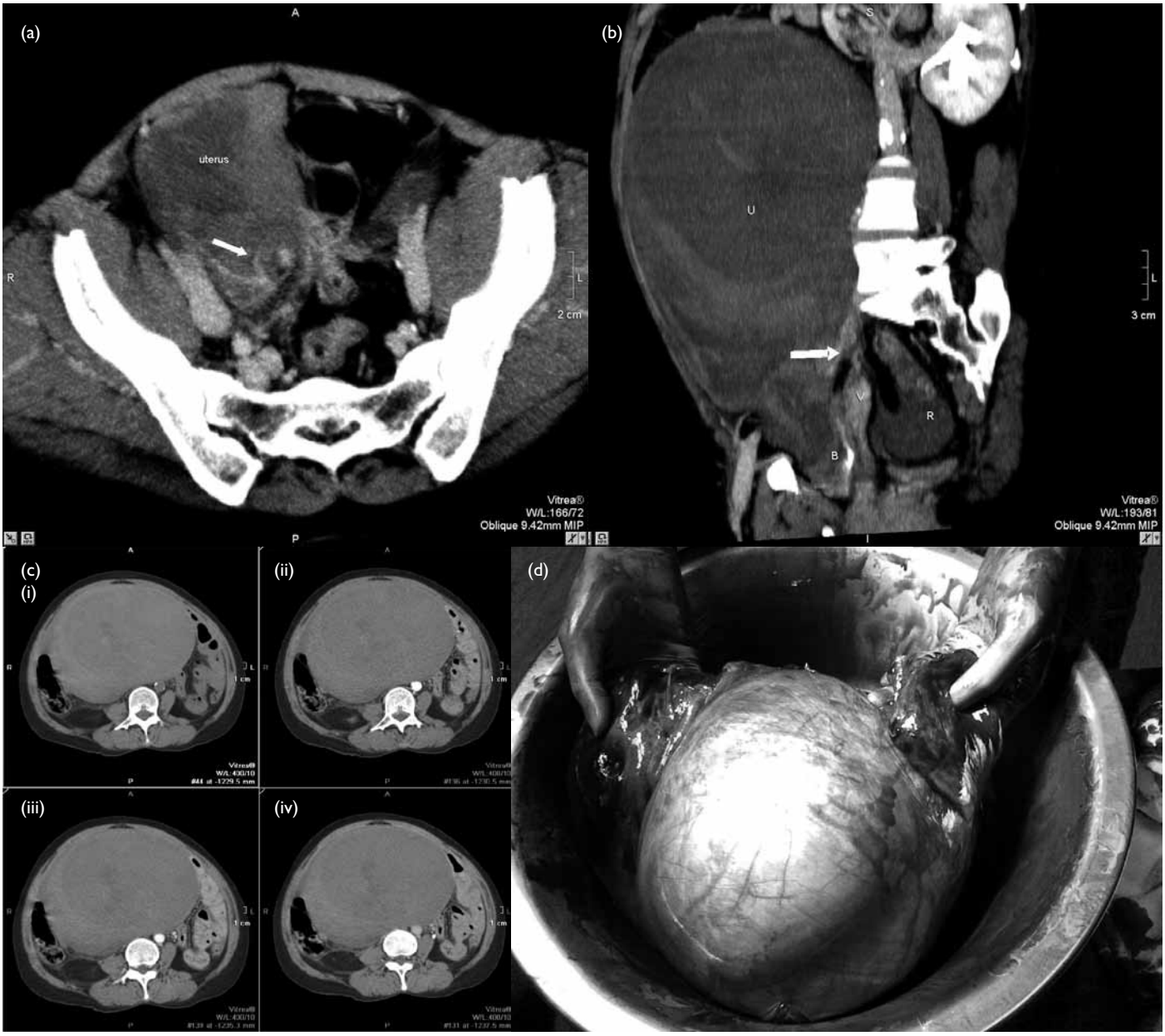

FIG 4. Torsion of the uterus in a postmenopausal woman who underwent emergency hysterectomy and oophorectomy
(a) Axial computed tomographic (CT) image showing the uterine cervix with a whirled appearance (arrow). (b) Oblique coronal CT image showing the uterine cervix with a whirled appearance (arrow). (c) Axial CT images of the abdomen in the (i) non-contrast, (ii) arterial, (iii) portovenous, and (iv) delayed phase showing lack of contrast enhancement of the uterus compatible with gangrenous changes. (d) Intra-operative photo showing a gangrenous uterine body, bilateral fallopian tubes, and ovaries (photograph courtesy of the Department of Obstetrics and Gynaecology, Pamela Youde Nethersole Eastern Hospital, Hong Kong; reprinted with permission)

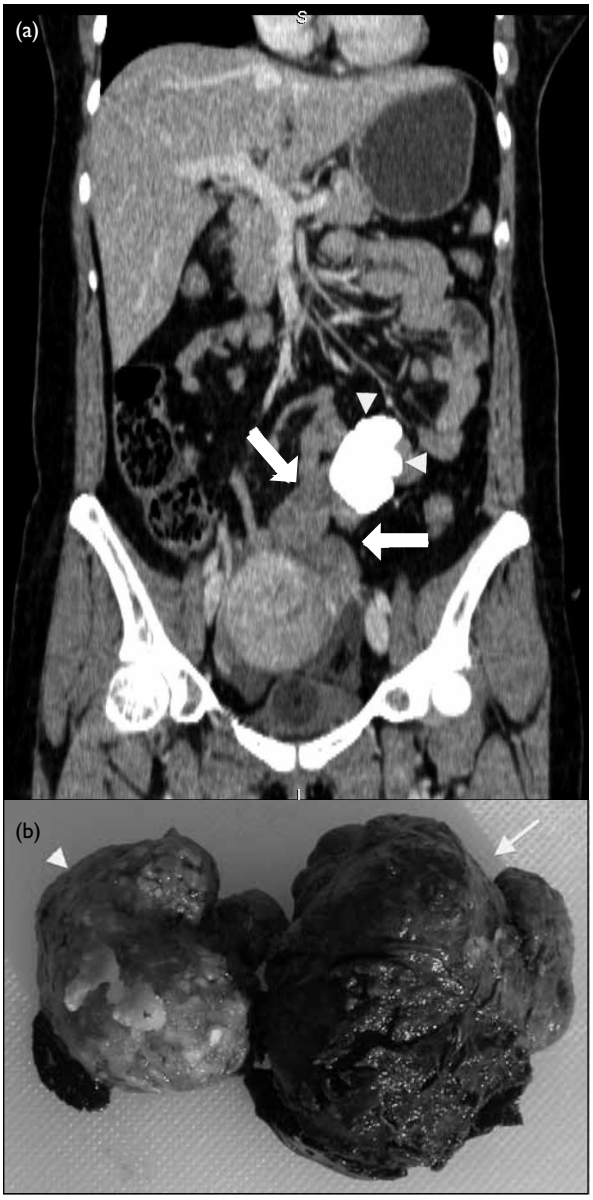

FIG 5. Tubo-ovarian torsion
(a) Coronal computed tomographic image of the abdomen and pelvis showing a heterogenous mildly enhancing tubular structure in the left adnexal region (arrows), representing a thickened fallopian tube. An irregular calcified mass is noted at the superior aspect of the tubular structure in the left adnexal region (arrowheads). (b) Pathological examination of the specimen showed a haemorrhagic infarct of the left fallopian tube (arrow). The nature of the calcified mass (arrowhead) could not be determined and was too hard for paraffin section sampling thus precluding histological examination (photograph courtesy of the Department of Pathology, Pamela Youde Nethersole Eastern Hospital; reprinted with permission)

Complications of transverse colon volvulus include bowel gangrene and perforation.

Torsion of the uterus

Torsion of the uterus is defined as a rotation of the uterus on its long axis of more than 45°.[11] Causes of uterine torsion include abnormal foetal presentation, fibroid, congenital uterine anomaly, pelvic adhesions, and adnexal masses.[11,12] Uterine torsion is a rare condition; since 1909, when it was first described, only about 200 cases of uterine torsion have been reported.[13] Since this is a rare condition, the clinical course, prognosis, and mortality rate is not well documented. The clinical presentation varies from non-specific mild abdominal discomfort to acute abdomen with shock.[13]

Plain radiograph and CT findings of gas in the cavity of a twisted uterus have been described as a feature of torsion of the uterus.[14] By ultrasound, torsion of a myomatous uterus may be suspected if fibroids shown on previous ultrasound scans have changed position.[14] By CT, a whirled structure in the uterine cervix, representing twisting at the uterine cervix, may be seen (Fig 4a, 4b). In patients with haemorrhagic infarction of the uterus secondary to torsion, areas of hyperdensities and lack of contrast enhancement may be seen on CT (Fig 4c). Features of uterine torsion shown by magnetic resonance imaging (MRI) have been described in the literature.[12] The wall of the upper vagina changes from the normal H configuration to an X-shaped configuration in torsion of the uterus. Differential diagnoses based on imaging features include ovarian or adnexal torsion and massive infarct inside a leiomyoma.

Uterine torsion may progress to gangrenous changes in the uterus (Fig 4d), which can be detected by CT. Hysterectomy should be considered for postmenopausal women with uterine necrosis caused by prolonged torsion.[13] For uncomplicated cases in premenopausal women, detorsion of the uterus may be considered.[15] Bilateral plication of the round or uterosacral ligaments may be considered to prevent recurrence of uterine torsion.

Tubo-ovarian torsion

Tubo-ovarian torsion is a gynaecological emergency requiring prompt surgical intervention. Ovarian torsion is frequently associated with an ipsilateral ovarian tumour or cyst, which occurs in 50 to 81% of patients.[16] Ovarian torsion can also occur in healthy ovaries, usually in paediatric patients, in whom the adnexa are especially mobile. Patients with ovarian torsion often present with abdominal pain.[16]

Ultrasound findings of adnexal torsion are non-specific. The role of ultrasound in the early diagnosis of adnexal torsion is not yet fully established.[16] Computed tomography and MRI are commonly used to detect features of ovarian torsion.[16,17] Common imaging features by CT and MRI include eccentric wall thickening of adnexal cystic masses and a tubular mass–like structure, representing a thickened fallopian tube (Fig 5a).[16] Other features

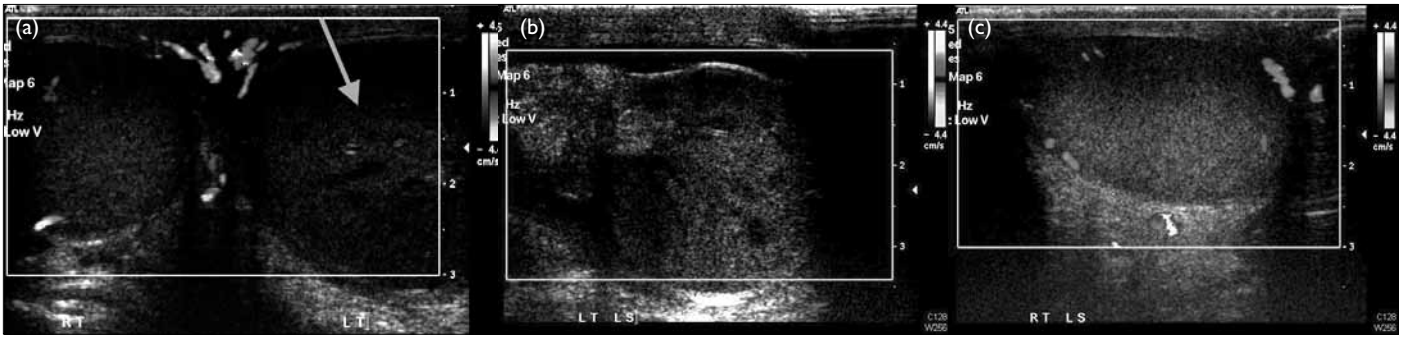

FIG 6. Testicular torsion
(a) Ultrasound examination of both testes showing an enlarged left testis (arrow) with decreased echogenicity and absent vascularity. At emergency operation, 720° torsion of the left testis was confirmed and the left testis was gangrenous. Left orchidectomy and right orchidopexy were performed. (b) Colour Doppler ultrasound examination of the left testis showing a relatively enlarged left testis with absent blood flow. (c) Ultrasound examination of the healthy right testis

on CT and MRI include ascites and deviation of the uterus to the side of the twisted ovarian mass.[16,18] Differential diagnoses based on imaging features include ruptured functional cyst, pelvic inflammatory disease, and ectopic pregnancy.

Ovarian torsion may be complicated by haemorrhagic infarction, which may lead to peritonitis and death. The presence of haemorrhagic infarction of the fallopian tube and ovary can be detected by CT and MRI. Prompt and accurate diagnosis and treatment may make it possible to conserve the normal ovarian structure by untwisting the pedicle and resecting the ovarian cysts or tumours.[16] When complete torsion is suspected, immediate surgery is necessary to remove the damaged tissue (Fig 5b).[18]

Testicular torsion

Acute testicular torsion is a surgical emergency. Congenital malformation of the processus vaginalis is the most common cause of testicular torsion, accounting for 90% of cases. About 4 to 8% of cases are related to trauma.[19] Testicular torsion may result in testicular ischaemia. Delay in diagnosis may risk testicular viability.

Commonly used imaging modalities include Doppler ultrasound and radionuclide imaging. Imaging features of testicular torsion on Doppler ultrasound include decreased or absent blood flow in the ischaemic testis when compared with the asymptomatic testis. The ischaemic testis may be enlarged with decreased echogenicity (Fig 6).[19] Studies have shown that Doppler ultrasound examination has a sensitivity of 66.7 to 100% and a specificity of 94.3 to 98.8% for detecting testicular torsion.[20] In scintigraphy, decreased delivery of radiotracer to the ischaemic testis can be seen, resulting in a photopenic lesion. Although scintigraphy may be more sensitive for testicular torsion, ultrasound is often more readily available.[19]

Differential diagnoses to consider include epididymo-orchitis, torsion of the appendix epididymis, and testicular tumour. By ultrasound, an enlarged hypoechoic epididymis with increased colour Doppler flow could help differentiate epididymo-orchitis from testicular torsion.[21] Ultrasound features of torsion of the testicular appendix that could help differentiate it from testicular torsion include an enlarged appendix testis.[21] Torsion of the testicular appendix requires no surgical intervention and usually resolves spontaneously.

Once testicular torsion is diagnosed, surgery should be considered to restore blood flow to the testis. If the testis is not viable, orchidectomy should be considered. Prophylactic orchidopexy of the contralateral testis is recommended as the anatomic abnormality that predisposed the testicle to torsion may be bilateral.[19]

Conclusion

Torsion and volvulus of the body often have non-specific and vague symptoms that require a high index of suspicion for prompt and accurate diagnosis. Imaging can facilitate the diagnosis of torsion and volvulus of the body, helping clinicians to avoid irreversible complications of torsion and volvulus.

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