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PICTORIAL REVIEW

CT features in surgically proven cases of ovarian torsion—a pictorial review

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ABSTRACT

Ovarian torsion is a surgical emergency characterized by a partial or complete rotation of the ovarian vascular pedicle, causing obstruction to venous outflow followed by arterial inflow. Clinically, ovarian torsion frequently mimics other causes of acute pelvic pain such as appendicitis, diverticulitis, renal colic etc. Ultrasonography is the first-line imaging modality of choice for evaluation of ovarian torsion. MRI is useful as a problem-solving tool in patients with equivocal or non-diagnostic ultrasonography studies. CT is ordinarily not utilized in a young female with suspected ovarian torsion due to the radiation dose. However, the significant expansion in use of CT imaging in emergency departments for female patients presenting with acute abdominal pain has increased the likelihood that ovarian torsion may be first seen on CT. In addition, a non-specific clinical presentation may lead to an initial imaging with CT rather than ultrasonography. Ultrasound features of the ovarian torsion are well known and sufficiently described across literature as compared with the CT scan findings. In view of the increasing usage of CT as the modality of choice in emergency settings, it is imperative for the radiologist to familiarize with the CT features of ovarian torsion. An early correct diagnosis by the radiologist in clinically unsuspected cases, facilitating a prompt surgery to restore the ovarian blood flow can prevent permanent irreversible damage. There is limited published data available on the CT features of ovarian torsion. This pictorial essay illustrates CT findings with histological correlation of surgically proven ovarian torsion in our institution. These patients were primarily investigated with CT scan for acute pelvic pain ascribed to non-gynaecological causes such as bowel or urinary tract lesions.

INTRODUCTION

Ovarian torsion refers to a complete or partial twist of the ovary on its vascular pedicle resulting in a compromised blood supply. The term adnexal torsion includes torsion of the ovary, fallopian tube or both,¹ as well as that of extra-ovarian masses such as fimbrial, para-ovarian, appendageal cysts or subserosal fibroids.² It is a well-known but rare cause of female pelvic pain.^{1,2}

Ovarian torsion often mimics other causes of acute abdomen such as appendicitis, diverticulitis, renal colic or gastroenteritis. Misleading clinical symptoms may result in a missed diagnosis and delay in treatment. Radiological imaging is therefore essential to facilitate an early diagnosis and a timely surgical intervention.² If the clinical evaluation indicates a bowel or urinary tract source for the patient's symptoms, CT rather than ultrasound is used as the initial modality of investigation.^{2,3}

PATHOPHYSIOLOGY OF OVARIAN TORSION

Twisting of the ovary on its suspensory ligament which contains the ovarian vessels, nerves and lymphatics results in a sequential vascular compromise. The low pressure venous and lymphatic structures are first affected with resultant ovarian oedema and enlargement. Persistent torsion causes stretching of the ovarian capsule and an increase in the ovarian pressure leading to arterial occlusion, thrombosis and haemorrhagic infarction of the ovary.¹⁻³ Untreated torsion may lead to systemic infection, inflammation and even death.²

EPIDEMIOLOGY, PREDISPOSING CONDITIONS AND CLINICAL FEATURES

Ovarian torsion is rare, accounting for 2–3% of gynaecological emergencies.^{2,3} An underlying ovarian mass such as a functional cyst, benign neoplasm such as mature cystic teratoma (dermoid cyst) or malignancy predisposes to ovarian torsion and may serve as the lead point in 50–90%

of cases. Enlarged cystic ovaries are another predisposing factor for torsion in females with ovarian hyperstimulation syndrome resulting from ovulation induction for *in vitro* fertilization.³

Ovarian torsion can occur at any age.¹ However, an increased incidence is noted in the first year of life, at menarche and during pregnancy.^{2,3}

Patients with pelvic inflammatory disease or endometriosis are less prone to ovarian torsion due to the presence of adhesions, limiting the mobility of the ovaries. Ovarian torsion has been reported to be more frequent on the right side as the mobility of the left ovary is relatively limited due to adjoining sigmoid colon.^{2,3}

The classical presentation of ovarian torsion is of abdominal pain and adnexal tenderness accompanied by a palpable mass. However, this is not commonly encountered.³ Ovarian torsion typically presents as a non-specific acute pelvic pain which may be accompanied by nausea, vomiting and low-grade fever. This is often confused with non-gynaecological conditions such as acute appendicitis, diverticulitis, renal colic or common gynaecological conditions such as pelvic inflammatory disease, haemorrhagic corpus luteal cysts and endometriosis.^{2,3} Occasionally, episodes of torsion and detorsion can result in recurrent pain, confounding the diagnosis even further.^{1,3}

CT FEATURES IN OVARIAN TORSION

Clinical evaluation has a low accuracy for diagnosing ovarian torsion. Imaging plays an important role in making a diagnosis of torsion in clinically ambiguous cases. Ultrasound is the initial imaging modality of choice for evaluation of lower abdominal or pelvic pain in females.^{2,4} However, ultrasound is neither 100% sensitive nor specific for diagnosing adnexal torsion.^{3,5} MRI is used especially as a problem-solving tool in sonographically inconclusive cases. Some centres use MRI as the first-line imaging tool for young females with acute abdominal or pelvic pain of uncertain aetiology, especially in pregnancy.⁶ It may also help assess ovarian viability pre-operatively.¹

Although CT should not be the first imaging modality of choice in young females with pelvic complaints, it is commonly used as an initial investigation in emergency departments to assess female patients with non-specific acute abdominal pain. Very often, it may be the first imaging modality available to patients presenting with an unexpected diagnosis of ovarian torsion.⁴ CT is also used as an adjunct if the ultrasound findings are inconclusive or if the lesion is not well depicted sonographically.¹

CT features of ovarian torsion include an enlarged ovary with or without an underlying mass or containing small peripheral hypoattenuating cystic structures around an oedematous ovarian stroma. A twisted pedicle may also be seen. Although these features are similar to those on ultrasound, CT can show multiple additional features of ovarian torsion which increase the diagnostic certainty.³ These include ovarian haemorrhage, abnormal ovarian enhancement, deviation of the uterus to the side of the torsion, thickened fallopian tubes, engorged vessels on the twisted side, ascites, obliteration of fat planes, haematoma and

gas within the tortured mass.^{1,3} Table 1 summarizes the CT features of ovarian torsion.

Ovarian morphology

The normal ovary can be recognized on CT as an ovoid soft-tissue structure in the ovarian fossa, located along the pelvic side wall bounded by the broad ligament anteriorly, external iliac vessels superiorly, the ureter and internal iliac vessels posteriorly and the ovarian ligament medially. The readily identifiable ovarian vein can be followed along the anterior surface of the psoas major muscle to the level of the ovary, thus helping in ovarian localization.

An enlarged ovary (>4.0 cm in maximal dimension) is the most common but fairly non-specific CT finding of ovarian torsion. Depiction of the central afollicular stroma (resulting from haemorrhage and oedema) with peripherally displaced follicles in an enlarged ovary on CT increases the specificity³ (Figure 1).

CT can identify an underlying ovarian mass which serves as a lead point for torsion. However, not all ovaries with a mass in patients with acute pelvic pain are tortured. Hence, other supportive clinical or imaging features are required to establish the diagnosis of torsion.³ The most common lesions associated with ovarian torsion are physiological cysts (follicular or corpus luteal).³ The most commonly associated tumour is dermoid^{1,2} (Figure 2). Other benign and malignant tumours are less commonly seen. The tortured cystic ovarian masses may show smooth eccentric or concentric wall thickening (Figure 3). However, its absence does not rule out the diagnosis. Eccentricity and a greater degree of wall thickening have been reported in haemorrhagic infarctions.^{3,7}

Haemorrhage within the ovary, fallopian tube or haemoperitoneum are less common findings following torsion; the extent of which depends on the degree and duration of the torsion.² Haemorrhagic infarction of the ovary develops later than oedema and is associated with subacute haematoma. This is best detected on unenhanced CT as a layering haematocrit level within a cystic ovarian mass or high-attenuation intraparenchymal haematoma within an enlarged ovary.³

Disrupted blood flow in ovarian torsion results in an abnormal ovarian enhancement on contrast-enhanced CT (Figures 2 and 4). However, normal enhancement may be seen in a tortured ovary in case of intermittent, partial or recent torsion or where a dual blood supply exists.² Hence, the presence of enhancement does not exclude torsion. Absent or minimal heterogeneous enhancement indicates evolution from ovarian ischaemia to infarction and is a rather specific feature of torsion.³ Absent enhancement of a solid enlarged ovary may be difficult to distinguish from a non-enhancing cyst on CT. Internal heterogeneity of the non-enhancing twisted solid ovary may aid in distinguishing it from a simple ovarian cyst.³

Twisted pedicle and thickened fallopian tube

An ipsilateral twisted pedicle is the most specific feature of ovarian torsion (Figure 3). However, it is only identified in less than one-third of the patients on CT. Whenever demonstrated, it

Table 1. CT features of ovarian torsion

Specific features	• Ipsilateral twisted pedicle ^a
	• Thickened fallopian tube with target or beak-like appearance
	• Central afollicular stroma with peripherally displaced follicles in a unilateral enlarged ovary
	• Abnormal ovarian enhancement—absent or reduced
Non-specific but commonly seen features	• Ovarian enlargement ^b
	• Adnexal mass
	• Mural thickening of the cystic adnexal mass
	• Uterine deviation to affected side
	• Misplacement of the torted ovary
	• Visualization of uninvolved ovary
	• Infiltration of the periadnexal fat and obliteration of the normal pelvic fat planes
	• Pelvic ascites
Less common features:	• Gas within the torted mass
	• Adnexal haemorrhage, haemoperitoneum

^aCan be considered pathognomonic.³

^bThe most sensitive feature.^{1,3,8}

confirms the diagnosis. Multiplanar reformations may identify this finding as a helical configuration of the vascular pedicle, known as the “whirl sign” (Figures 3 and 5). This is best appreciated on the sagittal or coronal planes. Contrast-enhanced CT can help distinguish the thickened swirling configuration of the broad ligament from the ovary and uterus.³ A target-like appearance of the twisted pedicle with intervening fat is highly suggestive of torsion⁷ (Figure 5).

Thickening of the fallopian tube has been seen in up to 84% of the cases with ovarian torsion.⁷ It is due to congestion and oedema or may indicate a twisted oedematous pedicle. The thickened fallopian tube may have an amorphous or tubular mass-like appearance (Figure 5) located between the adnexal mass and uterus, or may be seen as a beak-like protrusion extending from

the uterus and partially covering the adnexal mass.^{2,7} However, it may be difficult to visualize the fallopian tube in the presence of a large complex adnexal mass on CT scan.⁸

Ancillary findings

Uterine deviation to the involved side and misplacement of the torted ovary in the pelvis (to the contralateral side or to a far anterior or posterior midline position) are important CT signs of adnexal torsion² (Figures 3 and 5). The normal uninvolved ovary should be clearly visualized and localized to the correct side to accurately diagnose misplacement of the twisted ovary.^{5,8} Infiltration of the periadnexal fat is another important CT finding in adnexal torsion.⁸ Pelvic free fluid (Figure 1) is a common but non-specific finding that represents transudate from the ovarian capsule due to venous and lymphatic obstruction.⁵

Figure 1. A 25-year-old female with known polycystic ovarian syndrome. Axial (a) and coronal (b) contrast-enhanced CT shows a grossly enlarged right ovary with multiple peripherally placed follicles, prominent central hypodense oedematous stroma (thin white arrow) and a small amount of pelvic free fluid (arrowhead). The left ovary is normal in size and enhancement (thin black arrow). Laparoscopy showed right ovarian torsion. Detorsion of the right ovary, adhesiolysis and hydrotubation were performed.

Figure 2. A 29-year-old female with extreme left iliac fossa pain and tenderness with guarding. Contrast-enhanced CT (a) shows a bulky left ovary (thin white arrow) with a dermoid cyst (asterisk), enhancing less than the contralateral normal ovary (thin black arrow) adjacent to the uterus (black star). Laparoscopy revealed a 10-cm-size left ovarian cyst in the pouch of Douglas, twisted five times around the pedicle. The left ovary and fallopian tube were mottled upon entry. Detorsion and cystectomy were performed. Histology of the cyst showed mature cystic teratoma. The haematoxylin and eosin-stained image ($\times 200$ magnification) (b) shows keratinized stratified squamous epithelium (left, asterisk) partially lining the cyst with areas of denuded epithelium, haemorrhage and fibrin (right, arrow), consistent with cyst torsion.

Differential diagnosis of ovarian torsion and diagnostic pitfalls of CT

Various gynaecological conditions may simulate ovarian torsion clinically or on first-look imaging (Table 2). Any of these conditions may be seen as a complex adnexal mass on CT in a female presenting with acute pelvic pain. Ovarian lesions with

haemorrhage such as ectopic pregnancy, endometriosis, haemorrhagic functional cyst or tumours may mimic torsion on CT. The absence of a twisted pedicle and demonstration of normal ovarian morphology and enhancement should decrease the level of suspicion for underlying torsion in such cases. A combination of multiple CT features of torsion listed in Table 1

Figure 3. A 25-year-old female with ovarian torsion. Bedside transabdominal (not shown) ultrasound revealed a large anechoic unilocular pelvic cyst. Contrast-enhanced CT (a-d) shows a large left adnexal cystic mass rotated to the right with a swirled pedicle ("whirl sign") pathognomonic for torsion (wavy arrows). The cyst shows a smooth, eccentric wall thickening at the attachment of the pedicle (arrowheads). A right dermoid cyst with fat attenuation (asterisk) and calcification (thin arrow) is also noted. Laparoscopy showed a 20-cm left ovarian cyst torted twice around the ovarian pedicle. The left ovary was exteriorized and detorted followed by bilateral open ovarian cystectomy. Histology confirmed a right dermoid cyst and left ovarian mucinous cystadenoma.

Figure 4. A 13-year-old female presented with an acute abdomen with non-radiating right iliac fossa pain, vomiting and fever for 3 days. Clinical suspicion was of a possible acute or ruptured appendicitis. Contrast-enhanced CT shows an enlarged, hypo enhancing right ovary (arrowheads) with a large unilocular, thin smooth-walled cyst inseparable from it (thin white arrows). Laparoscopy showed right adnexal torsion with a paraovarian cyst. Detorsion was performed, and the gangrenous paraovarian cyst was excised. Haematoxylin and eosin-stained image ($\times 100$ magnification) shows a simple cyst with fibrous wall associated with extensive haemorrhage (asterisk) along the wall and vascular congestion (arrows). No definite epithelial lining can be seen. Features are consistent with cyst torsion.

would increase diagnostic certainty. A negative serum beta-human chorionic gonadotropin test helps to exclude ectopic pregnancy. Some pre-disposing conditions such as ovarian

hyperstimulation syndrome and polycystic ovaries may show massive ovarian enlargement even in the absence of ovarian torsion. An appropriate clinical history and the presence of

Figure 5. A 37-year-old female with ovarian torsion. Contrast-enhanced CT shows left ovarian cystic neoplasm (thick white arrows) rotated anterosuperior to the uterus (a, asterisk). The axial image (a) shows step-ladder pattern of the ovarian vessels along the left wall of the mass (thin white arrow). The coronal images (b–d) show twisting of the left ovarian vessels and a target-like appearance of the twisted pedicle with intervening fat (arrowheads). The thickened fallopian tube is seen to the left of the mass as a tubular structure (thin black arrows). The right ovary was seen in its normal location (not shown). On laparoscopy, a 10-cm left ovarian cyst torted once around its pedicle was noted. The left tube was oedematous. Viable left ovarian tissue was seen. Detorsion of the left ovary followed by left ovarian cystectomy was performed. Histology showed a mucinous cystadenoma. Haematoxylin and eosin-stained image ($\times 200$ magnification) shows the cyst wall partially lined by columnar cells, displaying abundant apical mucin and bland basal nuclei (e, asterisks). In some areas, the epithelium is denuded with associated haemorrhage consistent with cyst torsion (e, arrows).

Table 2. Differential diagnosis of ovarian torsion

Mimics of ovarian torsion	Overlapping features with ovarian torsion	Distinguishing features from ovarian torsion ^{3,8,9}
OHSS	Enlarged ovaries, peripherally arranged follicles around prominent central stroma	–Absence of a twisted pedicle, normal ovarian enhancement, absence of uterine deviation to affected side, misplacement of the ovary
Polycystic ovaries		–Bilateral involvement
		–History of ovulation induction for OHSS
		–Presence of clinical and hormonal features of polycystic ovarian syndrome
Ectopic pregnancy	Complex adnexal mass, haemorrhage, pelvic ascites, infiltration of the periadnexal fat and obliteration of the normal pelvic fat planes	–Absence of a twisted pedicle, normal ovarian enhancement, absence of uterine deviation to affected side, misplacement of the ovary
Haemorrhagic or ruptured functional cyst		–Serum β-HCG correlation for ectopic pregnancy
Haemorrhagic tumours		–Ring of peripheral enhancement, absent fallopian tube thickening in haemorrhagic or ruptured functional cyst
Endometriosis		–Tumour marker levels in haemorrhagic tumours, often bilateral masses with enhancing solid components with or without peritoneal carcinomatosis and lymphadenopathy
		–Multiple lesions in endometriosis such as endometriomas, dilated fallopian tubes, uterosacral ligament thickening and nodularity, typical MRI appearance
Pelvic inflammatory diseases	Complex adnexal mass, thickened tube, pelvic ascites, infiltration of the periadnexal fat and obliteration of the normal pelvic fat planes	–Absence of a twisted pedicle, normal ovarian enhancement, absence of uterine deviation to affected side and misplacement of the ovary, raised inflammatory markers, presence of hydrosalpinx, thickened uterosacral ligaments with or without lymphadenopathy
Infarction of a broad ligament or pedunculated subseroral fibroid	Complex adnexal mass, haemorrhage, pelvic ascites, infiltration of the periadnexal fat and obliteration of the normal pelvic fat planes, absent or reduced enhancement	–Identification of a normal ipsilateral ovary

β -HCG, beta-human chorionic gonadotropin; OHSS, ovarian hyperstimulation syndrome.

bilateral involvement are helpful in making this distinction. Infarcting fibroid with decreased enhancement, surrounding oedema and with or without internal haemorrhage may be confused with torsed adnexa. However, identification of a normal ipsilateral ovary would make the diagnosis less likely.^{3,8}

CONCLUSION

Ovarian torsion often presents as a clinically ambiguous condition. Females with lower abdominal pain are usually imaged using ultrasound initially. MRI can be used as

a problem-solving tool in patients with equivocal or non-diagnostic ultrasound studies. CT is usually not the first imaging modality of choice in a patient with suspected ovarian torsion due to the radiation dose to young females. However, the sharp increase in use of CT scanning in emergency departments for female patients presenting with acute abdominal pain has increased the likelihood that ovarian torsion may be first seen on CT. Thus, an awareness of the CT findings of ovarian torsion and a high index of suspicion is required for early diagnosis and intervention to preserve ovarian viability.

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