CT findings of female pelvis seen in emergency setting: Tips and clues to address the difficult diagnosis

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Authors: M. N. Rus Calafell¹, D. Armario Bel¹, M. Pardo Antunez¹, A. PLA¹, M. A. GELABERT², E. I. Castella Fierro¹; ¹Barcelona/ES, ²GIRONA/ES
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Learning objectives

1. To understand female pelvis anatomy.
2. To show the spectrum of female pelvis pathology visualized by CT in emergency.
3. To identify CT signs which allow us to recognize pelvic injury's origin.
Background

Pelvic pain of unknown etiology is a common cause of visiting emergency, being essential the correlation between imaging findings with clinical evaluation and laboratory testing.

An important issue that could help us in imaging interpreting is beta human chorionic gonadotropin levels for assessing pregnant or non-pregnant. Another thing to take into account is the phase of the menstrual cycle, considering all the physiologic changes that may be seen in pelvis organs during each phase.

Ultrasonography and MRI remain the primary imaging modalities if a gynecologic condition is suspected. However, CT is frequently performed initially for its availability in emergency, and it will be useful to exclude other pathologies.

This exhibit reviews several cases seen in our hospital of patients presenting acute lower abdominal or pelvic pain. Pathologic features found at CT were in some cases the cause of symptoms, while in other subjects they were just incidental findings.
Findings and procedure details

ANATOMY AND NORMAL FINDINGS

The pelvis is divided into two parts (Fig. 1 on page 12): the false (or greater) pelvis, between iliac fossae and part of the abdominopelvic cavity, and the true (or lesser), located inferiorly between bodies of ischia and contains the rectum, bladder, pelvic ureters, vagina, uterus and ovaries.

When evaluating female pelvis, the radiologist should be familiar with the complex ligamentous, vascular and visceral disposition.

1) Ligaments

Ligaments (Fig. 2 on page 12) give support to pelvic organs attaching them to pelvic wall and bones, and some of them also have other functions like carrying blood the supply to the organ.

- The Broad Ligament is formed by two layers of peritoneum that connect the uterus to the pelvic sidewall. They contain fallopian tubes, ovaries, uterine and ovarian vessels. The closest portion to the ovaries is called Mesovarium, which gives them support and carries the ovarian vessels from the suspensory ligament to the ovarian hilum.

- The Round Ligament attaches the anterolateral uterine fundus to the pubis and inguinal ring.

- The Cardinal Ligament connects uterus and upper vagina to the abdominal wall.

- The Uterosacral Ligament extends posteriorly from the lateral cervix and vagina toward the anterior body of the sacrum at S2-S3.

- The Suspensory Ligament of Ovary goes from the superolateral aspect of the ovary to the pelvic sidewall, and carries the ovarian vessels.

- The Ovarian Ligament extends medially from the ovary to the uterus.
Almost all of these structures are difficult to distinguish in CT. However, when ascites is present, some of them could be easily identified (Fig. 3 on page 13).

2) Spaces

The peritoneal folds overly inferiorly the bladder, uterus, posterior vagina and upper side of the middle-lower third of the rectum, creating two pouches (Fig. 4 on page 14): the recto-uterine (Douglas) and the vesico-uterine.

3) Vascular supply

The uterine arteries provide the primary blood supply to the uterus, origin from the anterior trunk of the hypogastric arteries and cross the ureter as it enters the bladder. The artery divides and sends smaller branches to the fallopian tubes, lower cervix and upper vagina (Fig. 5 on page 15).

Venous drainage of the upper vagina, cervix, uterus, and ovaries is via an extensive plexus of thin-walled, valveless veins that lie between the layers of the broad ligament within the parametrium.

The ovarian vein arises from the periuterine venous plexus, courses anterior to the psoas muscle, and drains into the left renal vein or into the inferior vena cava on the right side.

4) Pelvis Viscera

The uterus is a pear-shaped organ with a considerable variation in the size, morphologic features, and position depending on hormonal status, age and parity. During menstruation, the uterus enlarges with a more globular shape and is more vascular.

The wall is divided into three layers: the outer serosa, the myometrium and the endometrium. The innermost layer of the myometrium is known as the junctional zone.

Endometrial and myometrial enhancement at CT helps to distinguish the endometrial cavity from the uterus. Meanwhile the endometrial cavity is seen as a homogeneous central low-density region, some types of wall enhancement patterns have been described, the most known from Kaur and colleagues [4]: (Fig. 6 on page 16)
- **Type 1**: Subendometrial enhancement with or without associated subserosal enhancement. Young and premenopausal patients.

- **Type 2**: No early subendometrial enhancement. Early diffuse myometrial enhancement increases from the outer to inner myometrium over time. Pre and postmenopausal women.

- **Type 3**: Faint or minimal diffuse enhancement. Postmenopausal women.

The **cervix** represents the lower third of the uterus and consists of a highly enhancing inner zone corresponding to epithelium and a moderately enhancing outer portion.

The **ovaries** have a variable appearance depending on patient age, hormonal status and the phase of the menstrual cycle.

They are usually seen on either side of the uterus, are oval shaped and have a variable appearance of fluid or soft tissue attenuation.

In premenarchal women they can be difficult to localize due to their size and lack of follicular cysts, whereas in postmenopausal they are also small and are typically featureless with homogenous soft tissue attenuation.

The position is extremely variable, and is affected by uterine size and orientation, degree of bowel and urinary bladder distention and the presence of a pelvis mass or fluid.

**PATHOLOGICAL CONDITIONS**

1) **Uterus**

**Fibroids** are the most common benign tumors of the uterus, composed of smooth muscle cells interspersed with fibrous connective tissue. They are predominantly found in women of reproductive age and may enlarge during pregnancy or during oral contraceptive use.

They can be in a submucosal, intramural, or subserosal location.

The most common CT appearance of fibroids is enlargement of the uterus with lobulation of the outer contour (Fig. 7 on page 17, Fig. 10 on page 20).

Coarse calcifications are specific but are seen in only 10% of fibroids (Fig. 8 on page 18, Fig. 9 on page 19).
As fibroids enlarge, they outgrow their vascular supply and develop hyaline degeneration (necrosis) and hemorrhage, causing acute pelvic pain. In this case, they have a more cystic appearance, with diminished contrast material enhancement and areas of low attenuation. They may become quite large thereby suggesting primary ovarian disease. *(Fig. 10 on page 20)*.

The most common malignant condition of the uterus is **endometrial carcinoma**, which is usually seen as an enlarged uterus and a dilated fluid-filled endometrial canal with irregular borders *(Fig. 11 on page 21)*.

2) **Ovaries and adnexae**

Ovarian cysts are common incidental findings on MDCT of the female pelvis. Functional ovarian cysts are well circumscribed, usually less than 5 cm in diameter and have homogeneous low-attenuation aspect, with no contents or internal architecture. These physiologic cysts can be categorized further as follicular or corpus luteal cysts.

- **Follicular cysts** form when the dominant follicle fails to expel an oocyte. They measure 3-8 cm in diameter and are seen at CT as a well-defined round simple fluid collection with thin non-enhancing walls.

- **Corpus luteum cysts**, however, emerge due to transformation of the remaining bed once the ovulation and implantation have occurred. They have thickened, crenulated, hyperdense-enhancing walls, which correspond to the collapsed, vascularized follicular walls formed after ovulation. *(Fig. 12 on page 22)*.

Distinction between them on CT is difficult but is important because hypervascular corpus luteal cysts are more likely to be hemorrhagic.

One of the most common gynecologic causes of acute pelvic pain in a premenopausal woman is **hemorrhage into a follicular or corpus luteal cyst**, that we will suspect when we see:

- Cystic-mixed attenuation lesion with an enhancing cyst wall.

- Active extravasation of contrast material, indicating arterial bleeding *(Fig. 13 on page 23)*.
-- Hemoperitoneum.

*** Notice that if we detect hemoperitoneum in young women, we must also think in other entities such as ruptured ectopic pregnancy or ruptured hepatic adenoma.

Tumors may also be visualized incidentally in asymptomatic women.

Mature cystic teratoma (or dermoid) is shown as a mass with cystic or solid soft tissue components and dense calcifications (Fig. 14 on page 24). It usually causes no symptoms, although it has some complications such as torsion (16%), malignant degeneration (2%), rupture (1-2%) (Fig. 15 on page 25) and infection (1%).

Ectopic endometrium in the ovary is also referred as a endometrioma. Its appearance is variable and includes solid and cystic heterogeneous adnexal masses, with internal regions of high and low attenuation resulting from cyclical episodes of bleeding (Fig. 16 on page 26).

Between cystic neoplasms, serous and mucinous are the most common epithelial subtypes.

Serous cystadenomas are typically unilocular, thin-walled cystic masses, with an average size of 10 cm in diameter, and may be bilateral (Fig. 17 on page 27).

Mucinous cystadenomas are typically multilocular cystic masses with very thin septations, and may be larger than serous cystadenomas.

When we find these lesions, although incidentally, we must look careful for malignant criteria, which include:

Primary criteria (Fig. 18 on page 28)

- Partially solid or lobulated solid appearance
- Lesion diameter >4 cm
- Papillary projections
- Septa or wall thickness >3 mm
- Presence of tumor vessels
Secondary criteria
- Distortion of uterine contour
- Irregular or indistinct margins between the tumor and the myometrium, sigmoid colon or bladder
- Loss of soft tissue planes adjacent to tumor
- Distance <3 mm between the tumor and the pelvic sidewall
- Displaced or encased iliac vessels

Ovarian torsion, led by an underlying mass or not, is seen as:
- Tube thickening or a twisted vascular pedicle
- Enlarged ovary displaced, with peripheral displacement of follicles
- Hypoattenuating mass with no contrast enhancement (Fig. 19 on page 29)
- Deviation of the uterus toward the side of torsion
- Ascites

3) Pelvic inflammatory disease

CT is not usually performed when evaluating a pelvic inflammatory disease, unless a complication is suspected.

Early changes that can be seen include fat stranding accompanying an enlargement and enhancement of the cervical canal, ovaries and fallopian tubes, which appear dilated as a fluid collection.

When the disease progresses, loculated-serpiginous and thick-walled fluid collections (pyosalpinx) may develop as a result of accumulation of debris and purulent material (Fig. 20 on page 30).

Late findings are peritonitis, tubo-ovarian or pelvic abscess, adhesions or mesenteric infiltrates. The tubo-ovarian abscess (Fig. 20 on page 30) is visualized as a uni or bilateral adnexal mass that is thick-walled and fluid-density.
It also can present internal septations and gas bubbles that are specific but are rarely seen.

4) Postpartum

Normal postpartum uterus is enlarged, with an endometrial cavity that contains small amounts of fluid or blood, and even a small amount of air after vaginal delivery.

However, and an abnormal thickening of the endometrium or a larger amount of fluid and/or air is suggestive of endometritis in the setting of postpartum fever.

Another postpartum complication that may result in fever and abdominal pain is ovarian vein thrombosis, which is right-sided in 80-90% of cases.

5) Foreign Bodies and Devices

Intrauterine devices (IUDs) (Fig. 7 on page 17) are commonly used as a form of contraception. The radiologist should be familiar with its appearance, and assess for extraterine migration, slight downward positional shifts, fragmentation or associated infection.

Surgical material from a prior surgery could also be found as an incidental finding or causing pain duet to granulomatous reaction (Fig. 21 on page 31), and an accurate clinical history should be taken.

DIFFERENTIAL DIAGNOSIS

Gynecologic and postpartum conditions may mimic numerous disorders of abdominal pain such as appendicitis, diverticulitis, ileitis or genitourinary processes.

When unexpected large pelvic masses are found, differentiation of the organ of origin may occasionally be unclear. There are some landmarks we can use to locate the origin of the pelvic mass.

- The central location of the mass and inseparability from the uterus generally allow one to make a confident diagnosis of uterine fibroid. However pedunculated myoma with cystic
appearance may simulate an adnexal mass (Fig. 10 on page 20). The detection of a normal ovary may be a valuable clue in excluding the possibility of ovarian tumors (Fig. 11 on page 21), but normal ovaries may not be visible on imaging in postmenopausal women.

- The ovary in its typical location at the ovarian fossa is usually anterior or anteromedial to the ureter. This anatomic condition can help us to locate the origin of the injury. A mass arising from an ovary, when large enough, it will displace the ureter posterior or posterolaterally. However a large uterine, bladder or bowel mass can also displace the ureter posteriorly or posterolaterally.

- The lymph nodes at the pelvic sidewalls are extraperitoneal, lateral or posterolateral to the ureter and closely related to the iliac vessels. A large lymph node mass to the pelvic sidewall may displace the ureter medially or anteromedially (Fig. 22 on page 32).

- Vascular pedicle sign: The ovarian vein can be identified with CT and followed along the anterior surface of psoas muscle (Fig. 23 on page 33, Fig. 24 on page 34). The presence of an ovarian mass usually causes enlargement of the ipsilateral ovarian vessels (Fig. 25 on page 35, Fig. 26 on page 36). Asymmetrically enlarged gonadal veins is a useful clue in confirming the ovarian origin of a pelvic mass and for differentiating it from subserosal uterine myoma.

- The visualization of the ovarian suspensory ligament leading to and merging with a pelvic mass is a good landmark indicating the ovary as the origin.
Images for this section:

**Fig. 1:** Greater and Lesser Pelvis are divided by the pelvic brim (red line).

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Fig. 2: Basic anatomy of female pelvis, showing main ligaments and organs.

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Fig. 3: Left round ligament (arrow) towards anterior abdominal wall. Ascites helps to recognize it.

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Fig. 4: Sagittal CT enhanced depicts the two principal pouches: vesico-uterine (asterisk) and recto-uterine or Douglas (arrowhead).

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**Fig. 5:** Main pelvic arterial vessels.

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Fig. 6: a) shows an early subendometrial enhancement; b) a diffuse homogenous myometrial enhancement. Endometrial cavity (asterisk) is seen as a homogenous low-density area; and c) with faint or non-enhancement in a postmenopausal woman.

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Fig. 7: Multiple fibroids make the uterus appear enlarged and globulous. Note also that an UID is seen.

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Fig. 8: Fibroids with coarse calcifications (arrows).

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**Fig. 9:** Multiple fibroids with coarse calcifications (asterisks). Note also inflammatory findings on the right side (arrows). Due to clinical situation patient underwent surgery, which showed an appendicular plastron and as an incidental finding a large fibroid of the uterus.

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Fig. 10: Large uterine fibroid with hyaline degeneration.

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**Fig. 11:** a) and b) show a large and hypodense mass with enhancing walls (asterisk) that corresponded to an endometrial carcinoma. Note solid components and debris within the mass (arrowheads) that suggest malignancy. Note also how both adnexae are seen displaced laterally (arrows), a finding that should make us think in an non-ovarian origin.

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**Fig. 12:** Functional cysts. Upper image shows a left unilocular homogenous cystic mass compatible with a follicular cyst. Lower image depicts in same patient a right cystic mass with enhancing and thicker walls, features that lead us to a luteal cyst.

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Fig. 13: Young woman with Von-Willebrand disease came to emergency with hypotension and pelvic pain. a) axial CT contrast enhanced in arterial phase shows an heterogeneous right adnexal mass with solid and cystic components (asterisk), as well as an extravasation of contrast (arrows) compatible with active bleeding. Portal phase in axial (b) and coronal plane (c) shows an increase of contrast extravasation, which confirmed the acute bleeding.

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Fig. 14: Right ovarian with solid and fatty components compatible with teratoma (arrowhead). A bicornuate uterus is also seen.

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**Fig. 15:** Sequence of axial images depict a left adnexal mass compatible with teratoma with free fluid. A subserous fibroid is also seen more posteriorly on the left side. Laparotomy showed a ruptured teratoma with secondary peritonitis.

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Fig. 16: Right ovarian endometrioma (arrow), seen as an heterogeneous cystic mass with some hyperdense components that suggest recent bleeding.

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**Fig. 17:** Serous cystadenoma (asterisk) depicted as an unilocular thin-walled cystic mass.

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Fig. 18: Solid wall components (arrowhead) and septa (asterisk) in a mass are criteria that suggest high probability of malignancy. A mucinous cystadenocarcinoma was histologically proven.

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Fig. 19: Hypoattenuating mass with no contrast enhancement (asterisk). Laparotomy confirmed a left ovarian torsion.

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**Fig. 20:** Two different patients with IPD. a) showed loculated-serpiginous and thick-walled fluid collections mainly in left side that correspond to pyosalpinx (arrow). b) depicted a more organized fluid collection compatible with tubo-ovarian abscess (asterisk).

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**Fig. 21:** Large left mass surrounding hyperdense linear material. These findings were compatible with gossypiboma and a granulomatous reaction around it.

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Fig. 22: CT depicts a soft-tissue mass (asterisk) between the uterus and the left pelvic sidewall. The mass was determined to be an extraperitoneal lymph node mass because of: the presence of a thin fat plane between it and the left ovarian vein-adnexa (asterisk), which are intraperitoneal and are seen displaced medially; the encasement of the external iliac vessels; its location lateral to the ureter (visualized on images obtained at higher levels).

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Fig. 23: Patient seen before with degenerated fibroid. Left ovarian vein (arrowhead) and ureter (arrow) run anteriorly the psoas muscle. In an upper poistion (left image) the ureter locates lateral to the vein, afterwards it crosses posteriorly the vein and in lower positions (right image) we can see the ureter in a medial position.

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Fig. 24: Patient seen before with large fibroid and appendicitis. We can see quite symmetric ovarian veins, the left one draining to the left renal vein. Note that lack of opacification of ovarian veins is gradually due to shortly venous return at the moment of acquisition of the study.

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**Fig. 25:** Left ovarian endometroid carcinoma (asterisk). Coronal MIP reconstruction shows the left ovarian vein (arrow) larger and more opacified than the right (not shown), a sign that could help us in determining that the origin of the mass is on the left adnexa.

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Fig. 26: Right ovarian cystadenocarcinoma. Coronal MIP reconstruction shows a right ovarian vein (arrow) quite larger and opacified than left (not shown).

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Conclusion

- The radiologist should be familiar with the anatomy and the spectrum of CT features of gynecologic and postpartum pathology, as well as their mimics.

- Although CT is generally not the best imaging test for evaluating female pelvic disorders, there are some signs that could help us in the diagnosis approach.
References


