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#### REVIEW

# Multidetector CT appearance of the pelvis after cesarean delivery: normal and abnormal acute findings

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#### ABSTRACT

Cesarean section (CS) may have several acute complications that can occur in the early postoperative period. The most common acute complications are hematomas and hemorrhage, infection, ovarian vein thrombosis, uterine dehiscence and rupture. Pelvic hematomas usually occur at specific sites and include bladder flap hematoma (between the lower uterine segment and the bladder) and subfascial or rectus sheath hematoma (rectus sheath or prevescical space). Puerperal hemorrhage can be associated with uterine dehiscence or rupture. Pelvic infections include endometritis, abscess, wound infection, and retained product of conception. Radiologists play an important role in the diagnosis and management of postoperative complications as a result of increasing use of multidetector CT in emergency room. The knowledge of normal and abnormal postsurgical anatomy and findings should facilitate the correct diagnosis so that the best management can be chosen for the patient, avoiding unnecessary surgical interventions and additional treatments. In this article we review the surgical cesarean technique and imaging CT technique followed by description of normal and abnormal post-CS CT findings.

esarean section (CS) is the most frequent abdominal surgery performed in women. Its rate ranges from 3%–5% in Africa to 33% in the United States and 43.9% in Brazil with a reported worldwide global estimation of 15% (1). Complications such as hematomas, infection, abscesses, uterine dehiscence or rupture, pelvic thrombosis or thrombophlebitis may occur at an overall rate of 14.5%. Infection is the most common complication observed.

Ultrasonography (US) and multidetector computed tomography (CT) are frequently used to diagnose the most serious complications. During the first day after CS, it can be difficult to distinguish normal early postsurgical modification from possible uterine and pelvic complications. To date, only a few articles described the normal and acute abnormal CT findings of the female pelvis after CS (1–5). The aim of this article is to review the surgical technique of CS, and describe the expected normal and abnormal CT findings after CS as well as describe the most common acute complications. The additional role of MRI in the evaluation of normal and abnormal post-CS findings is also briefly described, in particular taking into account its added value in some specific settings.

#### Surgical technique

Cesarean delivery requires incision in the abdominal wall (laparotomy) and uterine wall (hysterotomy) (5). The most frequently performed surgical technique is the low transverse CS via a Pfannenstiel or Joel-Cohen skin incision (2–3 cm above the symphysis pubis); this type of uterine incision is usually recommended because it is related with less postoperative pain and blood loss, and it has the lowest risk for rupture in subsequent pregnancies (1, 5, 6). In this procedure, the fascia is opened and the rectus muscles are separated, followed by entrance into the peritoneum. A bladder flap may be generated by the incision of the loose reflection of the peritoneum that covers the uterus. Blunt dissection between the low uterine segment and bladder is performed and a low transverse incision is done in the myometrium.

Some surgical or obstetric indications may necessitate a classical (i.e., vertical) uterine incision in the body of the uterus; this type of incision is more susceptible to ruptures and can be associated with more complications both for the mother and the baby (1, 6). After delivery of the baby and the placenta, single- or double-layer suture is used to close myometrial layers, followed by suture of the fascia and the skin.

#### Imaging

US and CT are often used to diagnose acute complications of CS. US is the first choice because it can be executed at bedside, does not require the use of ionizing radiation and is cost-effective. However, US is limited in demonstrating the real extent of some abnormalities, which require the use of second-level techniques (7).

CT is the modality of choice for imaging postsurgical or intra-abdominal complications, such as hematomas, abscess, uterine dehiscence and rupture, and pelvic thrombophlebitis (1). Moreover, CT is usually employed to rule out active arterial bleeding in case of postpartum hemorrhage (5, 8). The reported protocols usually consist of three phases: an unenhanced scan (covering only the pelvis) followed by arterial phase (smart prep) and portal phase (80–90 s) scans extended to the whole abdomen or only to the pelvis for the arterial phase (5, 8). The unenhanced scans help to detect hematomas or free intra-abdominal fluid and to

#### Main points

- Different acute complications may follow a cesarean section (CS), such as hematomas, infection, abscesses, uterine dehiscence or rupture, pelvic thrombosis or thrombophlebitis.
- Ultrasonography (US) and multidetector computed tomography (MDCT) are the most frequently used methods to detect the acute complications after CS.
- During the first day after CS, it may be difficult to distinguish normal early postsurgical changes from possible uterine complications, because there is a large variability in the MDCT aspect of the normal CS scar, and there is an important overlap between normal and abnormal postsurgical findings.
- MDCT findings such as the presence of myometrial interruption and small hematomas in unusual locations (bladder flap hematoma, subfascial hematoma) do not represent pathologically significant findings, whereas other conditions such as major hematomas, uterine dehiscence and rupture have to be identified as significant complications.
- Given the absence of standardized imaging findings for interpretation of uterine dehiscence and rupture, the radiologic suggestion of complications in the report must be evaluated in the appropriate clinical setting.

discriminate active bleeding from calcifications, metal clips, and hemostatic content (5). Contrast-enhanced arterial phase scans detect active bleeding and can be used to construct three-dimensional reformatted images of the vessels, which are very useful if embolization is planned. Portal phase scans help to differentiate active arterial bleeding from engorged vessels, active venous bleeding, and pseudoaneurysms (5). A selective acquisition of delayed phase scans (3-5 min) can be added to clarify confusing images (5). A significant amount of radiation could be required to perform the three-phase technique. To reduce the radiation exposure in young patients of childbearing age, alternative protocols such a two-phase CT technique (unenhanced and enhanced phases or two enhanced phases without the unenhanced phase) could be used. Moreover, restriction of the arterial and portal phase studies from below the liver to the inferior pubic ramus or low-dose scanning protocols could be used to reduce the total radiation dose (5). In order to avoid the unenhanced scan, we suggest the use of ultra-delayed acquisition (2-3 hours after intravenous contrast administration) in such cases of doubtful imaging findings.

However, to assess the clinical efficacy of these different protocols other future studies will be useful (5, 8). Multiplanar reconstructed and volume rendering imaging with oblique reconstruction provide added diagnostic capabilities; these postprocessing techniques demonstrate fine anatomical detail that would be difficult to achieve using axial reconstruction alone. Despite radiation hazard, CT is usually preferred to magnetic resonance imaging (MRI) because it is cost effective and quick. On rare occasions, MRI is performed to clarify doubtful US and CT findings or to study patients with contraindication to intravenous administration of iodine contrast material (8).

Compared with CT, MRI has the advantage of a greater intrinsic contrast resolution, which enables more precise evaluation of the zonal anatomy of the uterus and its relations to other organs and pelvic structures. This helps to define more precise location of any normal and abnormal postpartum alterations, and to clarify the extent of specific uterine walls lesions, such as uterine dehiscence or rupture. In addition, MRI is a technique that allows multiplanar acquisitions on the three traditional spatial planes (axial, sagittal, and coronal) as well as on planes oriented according to the longitudinal axis of the uterus (e.g., axial oblique).

MRI is generally performed using 1.5 T scanners and a phased array multi-coil. The protocol consists of axial T1- and T2-weighted sequences both with and without fat suppression obtained in the sagittal and axial planes. Axial images extend from the aortic bifurcation to pubis symphysis. Dynamic enhanced T1-weighted images are obtained after an intravenous bolus injection of gadolinium (8).

# Normal acute findings of the postpartum

During the first days after CS, CT can be misinterpreted because some findings in the uterus may appear abnormal and mimic possible complications, but most of the times they are normal postsurgical appearance with no clinical significance (1, 8). The postpartum uterus is enlarged to twice its normal pre-pregnancy dimension (average size is 9×12×14 cm) (9). After delivery, the uterus shows a progressive involution from the gravid to the nongravid status, mainly during the first three days postpartum; the uterus progressively returns to its normal size within 6-11 weeks (5, 8). The postpartum endometrial cavity usually measures less than 2 cm (anteroposterior diameter) (4). Some fluid is commonly visible in the uterine cavity depicted as a hypodense area. Fresh blood clots are recognized by hyperdensity content within the endometrial cavity (Fig. 1) (5). Intrauterine fluid or blood debris should not be confused with infection or retained products of conception. Intracavitary gas, which is usually considered to be a sign of endometritis, may be found in asymptomatic women up to three weeks postpartum. Based on the literature, Hiller et al. (3) suggested that a small amount of gas in the endometrial cavity may be normal after CS, whereas abundant quantity of intrauterine gas, mainly at late postsurgical days, may suggest an infection.

The uterine and ovarian arteries are usually prominent in the postpartum period because blood flow increases during pregnancy. On contrast-enhanced CT, the uterine artery and its branches are visualized as tubular enhancing vessels in the parametrium. Intramural branches can be depicted as dotlike enhancing structures in the external part of the myometrium (Fig. 2) (5, 8). Increased vascularity of the myometrium may be a normal postpartum appearance in the ab-



**Figure 1. a, b.** Normal postpartum findings after CS. Sagittal reformatted CT image (**a**) obtained in a 34-year-old woman six days post-CS demonstrates an enlarged uterus with a normal low-attenuation interruption in the anterior lower uterine part (*black arrow*) and small air bubbles near the site of the surgical incision (*white arrow*). Note the modest amount of fluid in the uterine cavity (*asterisk*) and a focal myometrial increased vascularity at the site of prior placental implant (*arrowhead*). Sagittal reformatted CT image (**b**) obtained in a 27-year-old woman 37 days after CS demonstrates a normal postpartum uterine involution with persistence of a thin low-attenuation interruption in the anterior lower uterine part (*black arrow*) and sociated with CS.



**Figure 2. a, b.** Normal postpartum CT findings of uterus and uterine arteries in a 34-year-old woman six days post-CS. Axial CT image (a) through the pelvis displays an increased uterus with a low-attenuation central zone *(asterisk)*, due to intrauterine blood debris, fluid, and small air bubbles *(white arrow)*. Intramural arterial uterine branches *(arrowheads)* appear as dot-like or tubular enhancing structures in the myometrium. Oblique coronal MIP reformatted image (b) better demonstrates the myometrial arterial uterine branches *(white arrows)* and the cervicovaginal branches (black arrows) of the uterine artery as several tortuous enhancing tubular vessels. Note that the oblique coronal scan is oriented parallel to the axis of the uterus (U) in the sagittal plane.



**Figure 3.** Normal postpartum CT findings of increased uterine vascularity (*white arrows*) in a 35-year-old woman one day post-CS. Axial CT demonstrates an enlarged uterus with some fluid in the uterine cavity (*asterisk*). An area of increased endometrial vessels along the site of prior placental implant (*arrowhead*) is shown.

sence of abnormal bleeding. Localized areas of increased vascularity of the myometrium may correspond to the site of prior placental insertion (Fig. 3) (4). On contrast-enhanced CT images, the identification of the ovarian artery may be challenging because it is smaller than the ovarian vein. However, both ovarian arteries arise from the aorta below the emergence of the renal arteries and both vessels pass over the ureters and the external or common iliac vessels and lie lateral to the ureters along the psoas muscle. In the pelvis, both arteries reach the suspensory ligament of the ovary and enter the ovary at the mesovarian side (8).

Normal changes after CS include transverse or vertical interruption at the surgical site in the anterior lower segment of the uterus. In the postsurgical period, the uterine interruption is usually observed on CT as an oval or triangular hypoattenuating area in the myometrium (1, 2, 5). However, the low transverse incision presents ill-defined margins on axial CT images because it is parallel to the CT imaging plane. Sagittal and oblique axial reformatted CT images provide a better imaging of myometrial discontinuity by using imaging planes perpendicular and parallel to the surgical plane (5, 9). CT interpretation is often very difficult during the first days after CS, because normal early postsurgical changes and possible complications may have similar appearance (3). The myometrial discontinuity in the first postsurgical days in asymptomatic patients should not be read as possible complications such as uterine rupture or dehiscence (5, 9). Moreover, Hiller et al. (3), in agreement with previous studies (2, 10, 11), did not find any correlations between postsurgical days and width of the surgical scar or between the CT finding of a full-thickness myometrial wall gap and the presence of a true myometrial defect. A full-thickness uterine interruption at the surgical site is likely due to edema with areas of compromised blood supply during the early postsurgical periods and a thick scar at later postsurgical reaction (3). In our opinion, when a full-thickness wall defect is recognized alone on CT without associated symptoms and signs and in the absence of other CT findings (collection or hematoma), true uterine dehiscence is unlikely. This concept is important, because it may prevent unnecessary surgery on the basis of CT findings alone.

The same postpartum changes that may be evaluated on CT, such as increased uterine dimensions, pelvic effusion, and blood in the uterine cavity may also be accurately visualized on US and MRI exams. Additional normal findings that MRI can show compared with US and CT in the postpartum period include high signal intensity on T2-weighted images of the parametria due to edema and in the outer cervical stroma related to prior unsuccessful trial of a normal spontaneous vaginal delivery. Also MRI shows the incision site of CS, which is visualized as increased signal intensity on T2-weighted images. Low signal intensity at the incision site on T2-weighted images, probably secondary to subacute hematoma, should not be confused with dehiscence (10).

#### Abnormal findings of the postpartum: acute complications

Acute pelvic complications following CS include same types of adverse events that occur after any surgery. The most frequent acute complications related to CS are infec-

Table. Imaging of acute complications after cesarean delivery		
Acute complications	Imaging features	Associated findings
Bladder flap hematoma	Collection between the posterior wall of the bladder and the anterior wall of the lower uterine segment. Can be considered normal if <4 cm in size	Bleeding can spread to the broad ligaments, retroperitoneum and peritoneum
Subfascial hematoma or rectus sheath hematoma	Extraperitoneal collection in the prevescical space, posterior to the rectus muscle (or in the rectus sheath) and anterior to the peritoneum	Infection of the hematoma Skin complications (infection, abscess, dehiscence)
Uterine dehiscence	Incomplete rupture of the uterine wall, involving the endometrium and the myometrium with an intact overlying serosal layer	Bladder flap hematoma >5 cm Large pelvic hematomas
Uterine rupture	Complete rupture of the uterine wall with separation of all layers (including serosal) and direct communication between uterine and peritoneal cavity	Bladder flap hematoma >5 cm Large amount of blood Infection of the myometrium or parametrial abscess Direct communication with the endometrium
Ovarian and pelvic septic thrombosis and thrombophlebitis	Enlarged and tubular ovarian vein (or other pelvic veins) expanded by intraluminal low-density thrombus, surrounded by an enhancing vessel wall	Perivascular adjacent inflammatory stranding
Retained products of conception (RPOC)	Enhancing soft-tissue mass within the endometrial cavity	Variable degree of myometrial thinning
Endometritis	Thickened and distended endometrial cavity by fluid, gas, or debris	Endometrial enhancement can be depicted on contrast-enhanced images



**Figure 4. a, b.** Small bladder flap hematoma, in a 34-year-old woman with fever, pelvic pain and high white blood cell count, six days post-CS. Axial CT image (**a**) demonstrates the CS incision in the inferior uterine segment (*arrows*). A high-attenuation fluid collection (*asterisks*) with a small amount of gas is also present between the bladder and the uterus. No other pathologic findings were discovered. Sagittal reformatted CT image (**b**) better shows the relation of the small bladder flap hematoma (*asterisk*) to the surgical scar (*arrow*). The patient was successfully treated with antibiotic therapy.



**Figure 5. a, b.** Bladder flap hematoma in a 33-year-old woman with anemia, four days post-CS. Axial unenhanced CT image (**a**) and sagittal reformated contrast-enhanced CT image in the venous phase (**b**) demonstrate a high-attenuation collection with fluid-fluid level due to fresh blood (*arrowheads*), located anterior to the uterus (U). A high attenuation free fluid component is also present posterior to the uterus (*asterisk*). Sagittal reformatted CT image (**b**) shows the position of the bladder flap hematoma located between the lower uterine part and the posterior bladder wall (*arrowheads*), adjacent to the CS incision (*black arrow*), and the fluid collection in the pouch of Douglas (*asterisk*). Rectus muscles enlargement is present (*white arrow*). A hypodense myoma is also present in the anterior uterine wall (O). The patient recovered after blood transfusions and antibiotic treatment.

tion and hemorrhage and are classified in the Table.

#### **Bladder flap hematoma**

Bladder flap hematoma may arise after CS done with a low uterine transverse incision, because the peritoneum is cut between the uterine wall and the bladder and returned inferiorly. Bleeding and dehiscence at the lower uterine surgical site may lead to hematoma formation in the potential extraperitoneal space between the bladder and the lower uterine segment (1, 5).

At first evaluation with US, bladder flap hematoma may be seen as a well-circumscribed hyperechoic fluid collection between the uterus and the urinary bladder. US will also show debris and gas within the uterine cavity, which appear as echogenic foci causing posterior shadowing (1). At CT, the bladder flap hematoma is visualized as fluid collection (slightly hyperattenuating) between the posterior wall of the bladder and the anterior wall of the lower uterine segment. Generally bladder flap hematomas are small and can be interpreted as normal if the size is less than 4 cm on the axial plane (Fig. 4) (1). Hematomas larger than 5 cm are uncommon and have been associated with uterine dehiscence (5, 10). Therefore the presence of a large bladder flap hematoma (more than 5 cm in size) should be considered carefully and should induce a more scrupulous search for dehiscence (Fig. 5) (10). Extravasation from the low uterine transverse incision is usually limited by the overlying peritoneum but



**Figure 6. a**–**c.** Infected bladder flap hematoma with subcutaneous collection in a 30-year-old woman presenting with fever and pelvic pain, 34 days post-CS, with pelvic fluid collection at US. Axial unenhanced (**a**), axial venous phase contrast-enhanced (**b**) CT images demonstrate a high-attenuation fluid collection (*asterisks*) with a peripheral rim-enhancing (*arrowhead*) and multiple internal septa located posterior to the bladder wall and anterior to the lower uterine segment, due to an infected hematoma. Sagittal reformatted image (**c**) better shows the real extension of the collection (*asterisk*), close to the CS scar, which appears enlarged (*black arrow*). The collection (*asterisk*) spreads up to the uterine fundus. The postpartum uterus shows heterogeneous enhancement. In all figures, note the coexisting infected abdominal wall collection with rim-enhancement (*white arrow*). The patient underwent subtotal hysterectomy and bilateral salpingectomy with ovaries spared because of a diffuse inflammatory reaction of the pelvic anterior peritoneum and uterus.



**Figure 7. a, b.** Subfascial hematoma in a 31-year-old woman affected by Behcet disease who presented with pelvic pain and anemia 10 days post-CS. Axial CT image (**a**) in the arterial phase shows a high-attenuation collection in the rectus sheath (*asterisk*) with bilateral muscle enlargement, which extends posterior to the rectus muscles, particularly on the left side. No signs of active bleeding were depicted. Note the epigastric arteries as dot-like enhancing structures in the posterior rectus sheath (*white arrows*). The extension of the rectus sheath hematoma is better shown in the sagittal reformatted plane (**b**). Note the coexisting small bladder flap hematoma (*arrowhead*) between the bladder and the lower uterine segment adjacent to the CS (*black arrow*). Symptoms were solved by surgical drainage of the hematoma.

can extend to the broad ligaments, retroperitoneum, and peritoneum (1). Overlying infection of bladder flap hematomas will show gas within the fluid collection; internal septa with enhancing rim may be present (Fig. 6) (1). Surgical evacuation of large bladder flap hematomas may necessitate incision of the peritoneum. On MRI, the sagittal plane allows clean visualization of the low transverse uterine incision and bladder flap, slightly similar to CT reconstructions on the sagittal plane. The bladder flap is contiguous with the incision site, which is seen band-like in appearance and manifested as high signal along the anterior part of the uterus and has similar signal characteristics of moderately intense signal on T1- and T2-weighted images. Some bladder flaps show areas of low intensity signal on

T1-weighted images that are seen as high intensity on T2-weighted images due to fluid or edema (11).

## Subfascial hematoma or rectus sheath hematoma

Subfascial hematoma or rectus sheath hematoma is an extraperitoneal hematoma expanding into the rectus sheath or into the prevesical space, adjacent to the rectus muscle and transversalis fascia but anterior to the peritoneum, in continuity with the space of Retzius (the inferior extent of the prevesical space) (1, 5, 12). Most of the extraperitoneal hemorrhages are the consequence of an injury to the inferior epigastric vessels (arteries in particular) or their braches or a direct tear of the rectus muscle during CS. In fact, the inferior epigastric artery originates from the external iliac artery superior to the inguinal ligament and courses superomedially for a variable distance in the prevesical space before piercing the transversalis fascia and entering the posterior rectus sheath (12); it reaches the lower rectus abdominis and creates an anastomosis with the superior epigastric vessel (8). US demonstrates a cystic or complex collection deep in the rectus muscle and anterior to the bladder (13). Contrast-enhanced CT images show a hyperattenuating mass (70-90 HU) posterior to the rectus muscle or in the rectus sheath with ipsilateral muscle enlargement that can extend in the prevesical space and potentially cause hemoperitoneum (1, 5). Contrast-enhanced CT may also be helpful in detecting (or documenting) contrast material extravasation that represents active bleeding (1). Significant blood loss can result with subfascial hematoma, and up to 2500 mL of fluid may accumulate in this large space without manifestation of an evident abdominal-wall mass.

Active contrast extravasation outside the uterus on CT images can change the therapeutic decision, and selective arterial embolization is contemplated for those cases with no response to conservative approach (5, 8). Proper recognition of subfascial hematoma and its distinction from bladder flap hematoma is important because surgical drainage of a bladder flap hematoma requires incision of the peritoneum, while surgical evacuation of subfascial hematoma can be performed without this incision. More likely, subfascial hematoma and bladder flap hematoma coexist coincidentally as common complications of CS (Fig. 7) (12). However,

these hematomas have different sources of bleeding (epigastric vs. uterine vessels) and should be treated as independent entities. Moreover, differentiating subfascial hematoma from superficial wound hematoma is also vital because of the possibility of major blood loss with subfascial hematoma (1, 12). The rectus muscle is a useful landmark for distinguishing these two different kinds of hematomas, with the superficial wound hematoma placed anterior to the muscle and the subfascial hematoma placed posterior to the rectus muscle. Subcutaneous fluid collection and gas are not infrequent findings, but areas of gas and fluid organized at the surgical site in the subcutaneous tissue may indicate extensive infection and abscess formation (Fig. 8) (1, 9). CT can

also demonstrate complication of the skin as dehiscence of the site of the incision, with separation of the abdominal wall.

#### **Uterine dehiscence**

Uterine dehiscence or incomplete rupture of the uterus is characterized by an incomplete rupture of the uterine wall, commonly involving the endometrium and myometrium, with the overlying serosa maintaining its integrity (1). Uterine dehiscence is a very arduous CT diagnosis due to its overlap with the normal aspects of the CS. CT findings are nonspecific and there is a poor correlation with clinical-surgical findings, as previously demonstrated by some authors (3).

Incisional dehiscence and myometrial interruption can be recognized by a full-thick-



**Figure 8. a, b.** Infected abdominal wall collections and pelvic abscess in a 33-year-old woman who presented with fever, pelvic pain, and high white blood cell count three days post-CS, with a CT diagnosis of subfascial hematoma *(asterisks)* that was surgically evacuated. The patients underwent a second CT four days later for persistence of fever and pelvic pain. Axial **(a)** and sagittal reformatted **(b)** images show persistence of bilateral rectus enlargement *(asterisks)* and prevesical fluid collection with rim enhancement *(white arrows)* due to infection. Note the position of the fluid collection, anterior to the bladder (B) and the uterus (U). Coexisting small subcutaneous gas-containing fluid collections were surgically drained with diagnosis of mycoplasma superimposed infection and the patient was subsequently treated with antibiotic therapy.

ness transmyometrial gap with unclear margins at the site of incision (3). Free fluid, bladder flap hematoma, pleural effusion, bowel distension, and intrahepatic abscess are described as associated signs (1). The presence of a bladder flap hematoma larger than 5 cm or a big pelvic hematoma should raise suspicion for uterine dehiscence in the right clinical context (Fig. 9) (1). On the other hand, when a full-thickness myometrial wall gap is observed on CT, without other associated imaging features, such as collection or hematoma, and clinical symptoms, true uterine dehiscence is improbable (3). MRI is superior to CT for the diagnosis of uterine dehiscence; it has a higher sensitivity and specificity due to its multiplanar capability and greater soft-tissue contrast (1). MRI, particularly in the sagittal plane, can discriminate between uterine rupture and dehiscence by delineating all uterine wall layers and identifying an intact serosa covering the myometrial gap (10, 11, 14). On T2-weighted imaging, a normal CS scar will appear as a linear hyperintense focus in the myometrium, whereas a true dehiscence will appear as a hyperintense focus through the full thickness of the endometrium and myometrium, sparing the serosal layer. A small bladder flap hematoma can be present. Moreover, a true dehiscence is usually associated with a large hematoma or abscess that can be easily seen on MRI. Contrast-enhanced MRI is useful in confirming the thickness defect (14).

#### **Uterine rupture**

Uterine rupture occurs when all layers of the uterine wall are separated, including the serosal layer, with full thickness tear and



**Figure 9. a–c.** Uterine dehiscence in a 37-year-old woman with persistent fever and abdomino-pelvic pain three days post-CS. Axial CT images obtained at two different pelvic caudo-cranial levels (**a**, **b**) demonstrate an enlarged puerperal uterus with irregular CS incision in the anterior myometrial wall (*black arrow*) associated with a hyperattenuating gas-containing fluid collection (*white arrow*), anterior to the uterus. Posterior free fluid is also present (*arrowhead*). The endometrial cavity is expanded with fluid and air bubbles (*asterisk*). Sagittal reformatted plane (**c**) demonstrates a full-thickness transmural incision with loss of clear border of the myometrium (*black arrow*). Note the distended endometrial cavity with the presence of a myometrial inhemogeneity in the fundus at the site of the placental insertion (*white arrow*). Images and symptoms suggested uterine rupture or dehiscence and the patient was surgically treated. At surgery a uterine dehiscence at the right site of the CS was confirmed with associated right parametrial infected collection. Diffuse endometritis was also present.



**Figure 10. a, b.** Uterine rupture in a 38-year-old woman with hyperpyrexia, pelvic pain, and dyspnea with suspicion of pulmonary embolism, five days post-CS. Axial CT (**a**) shows a large rim-enhancing gas-containing fluid pelvic collection (*asterisk*) closed to the uterine CS site (*black arrows*). Right periuterine fluid collection and fat stranding are also present (*white arrow*). Sagittal oblique reformatted image (**b**) better shows the communication between the anterior pelvic collection (*asterisk*) and the endometrium extending through the uterine wall incision site (*black arrow*). Subfascial fluid-gas containing collection is also present (*arrowhead*). Images were highly suggestive for uterine rupture. This finding was surgically confirmed.

direct communications between the uterus and peritoneal cavity (1, 8). The rupture of the uterus is a potentially mortal complication (4, 7, 8). Patients usually complain of severe abdominal pain. Vaginal bleeding may be present (vary between spotting and massive hemorrhage). Intraperitoneal hemorrhage is usually important, with risk of hypovolemic shock for the mother (8, 15). Uterine rupture is usually recognized clinically and managed by laparotomy. However, some cases with clinically indolent signs and symptoms (intermitted bleeding) may be more likely to be diagnosed with imaging.

Transabdominal US can reveal a mild amount of free fluid in the abdomen, and the transvaginal US can demonstrate expected increased postpartum uterus size with normal thickness of endometrium, but the visualization of the uterine lower segment may not be clear enough to make a diagnosis of uterine rupture (16). Imaging findings of uterine rupture that the radiologists have to look for are focal interruption of uterine wall, hematoma in the broad ligament, and hemoperitoneum. Focal interruption of the uterine wall looks like a hypoattenuating defect inside the enhancing myometrium (1, 8, 15). The existence of gas within the uterine disrupted site spreading into the endometrial cavity and parametrium associated with the presence of a large amount of blood in the peritoneal cavity raises the probability of rupture in specific clinical scenarios (Fig. 10) (1, 8). The radiologist should be aware of the possibility of uterine rupture in the presence of a hemoperitoneum or an infection in the myometrium that expand into an infected bladder flap hematoma or parametrial abscess mainly if a direct link with endometrial cavity can be detected (1).

### Ovarian and pelvic vein thrombosis and thrombophlebitis

Ovarian and pelvic vein thrombosis and thrombophlebitis occurs in one out of every 600 cesarean deliveries, but its prevalence is presumably underestimated (1). The period of onset can vary from 2 to 10 days postpartum. It is usually unilateral (only 10%-14% of cases are bilateral), affecting commonly the right ovarian vein (up to 80%-90%), likely because it is usually larger than the left one, has multiple incompetent valves (1, 4, 7, 9), and merges obliquely with the inferior vena cava. Moreover, the retrograde flow from the left renal vein to the ovarian vein during pregnancy and postpartum is thought to be protective (4). The thrombus from the right ovarian vein can spread anywhere in the inferior vena cava or renal vein (1, 9). A bland thrombus may be complicated by thrombophlebitis particularly in postpartum infection as endometritis. Clinical diagnosis may be difficult because patients usually present fever, acute pelvic and flank pain rather than specific symptoms (4, 15). Moreover, ovarian vein thrombosis can be difficult to discriminate from appendicitis in the postpartum female. The diagnosis is usually achieved on contrast-enhanced CT, but can be made with US, although US imaging is often limited by overlying bowel gas in these patients (1). Contrast-enhanced CT imaging findings of thrombosis include enlarged and tubular ovarian or other pelvic veins expanded by intraluminal low-density thrombus, surrounded by an enhancing vessel wall (Fig. 11). Looking in the direction of gonadal vein from the pelvis to the inferior vena cava or left renal vein may help discriminate it from the ureter, appendix, or inferior mesenteric vein. Perivascular adjacent inflammatory stranding with an expanded gonadal vein encourages the diagnosis of thrombophlebitis and differentiates it from bland thrombus (1, 4, 15). Moreover, thromboembolic complications can involve pulmonary embolism and deep vein thrombosis (4). Also the evaluation of ovarian vein patency can frequently be established with MRI noninvasively without the administration of intravenous contrast. For example, the absence of acute perivascular edema on T2-weighted images is an additional sign that can exclude acute deep venous thrombosis (11).

# Uterine subinvolution: endometritis and retained products of conception

The physiologic reduction of the uterus to its normal size can be complicated by retained products of conception (RPOC), blood clots, or intrauterine infection or inflammation (5). The uterus will still look enlarged and demonstrate subinvolution. The retained placenta and decidua can act as a conduit for prolonged blood loss causing postpartum hemorrhage or as a nidus for infection. The principal causes of uterine subinvolution are infections (endometritis) and RPOC.

Endometritis is the principal cause of postpartum fever (1%-6% after cesarean delivery) (9, 15). Endometritis may proceed to myometritis, pelvic abscess, and septic thrombophlebitis (15). The symptoms of postpartum endometritis may vary from fever and abdominal pain to diffuse peritonitis and extreme uterine tenderness (7). CT is recommended for patients with no response to antibiotic therapy to evaluate uterine and extrauterine complications (9). On contrast-enhanced CT, severe cases may show thickening of the uterine wall and the endometrial cavity because of the presence of fluid, or sometimes gas or debris; enhancement of the endometrium can be depicted (9, 15). Some amount of gas can also be present in normal postpartum uterus, particularly after instrumentation. Therefore, the diagnosis of endometritis



**Figure 11.** Thrombosis of the myometrial veins in a 46-year-old woman with dyspnea and fever 12 days post-CS. Axial venous phase CT image shows enlarged puerperal uterus (U) with mildly distended endometrial cavity (*asterisk*) and bilateral, symmetric and tubular low-density structures into myometrial fundus probably due to thrombosed veins (*white arrows*). The patient did not show significant sign of pulmonary thromboembolism, but was treated with anticoagulant therapy.



Figure 12. Retained products of conception in a 40-year-old woman who presented with blood loss and anemia 55 days post-CS. Axial CT image demonstrates a small uterus with hypodense area with several tortuous enhancing tubular structures in the context (*white arrows*). Note the enlarged bilateral uterine arteries (*black arrows*). These findings were highly suggestive for vascular lacunae in a focal retained placenta.

cannot be made only on the base of imaging, and a proper clinical context must be present. Imaging features of pelvic abscess are commonly characterized by fluid-filled collection with thick and rim-enhancement associated with adjacent inflammatory stranding; gas with an air-fluid level and internal septations may also be observed (15).

RPOC is the most frequent cause of secondary or late postpartum hemorrhage; the frequency of RPOC increases in patients with placenta accreta. Pelvic pain and vaginal bleeding are more common symptoms (8). Correct diagnosis is essential for the appropriate treatment, which commonly requires either medical treatment (administration of uterotonics) or surgical treatment (dilatation and curettage of retained material) (4). In this setting, US is generally the first-line of imaging, performed transabdominally and transvaginally with specific consideration of the endometrium (thickened if >10 mm) or any focal hyperechoic masses within the endometrial cavity with increased vascularity at color Doppler US, although the absence of vascularity does not exclude retained products of conception (4, 5, 8). However, the diagnosis of RPOC is sometimes difficult because in a normal uterine postpartum involution, necrotic decidual tissue and blood clots may look like residual tissue (8). MRI should be performed only in patients with inconclusive US findings (8). Sometimes vascular lacunae are visible in RPOC.

On MRI, RPOC is seen as an intracavitary soft-tissue mass with variable enhancement with obliteration of the junctional zone. Although MRI findings of RPOC reveal variations in signal intensity and contrast enhancement, RPOC usually shows very high intensity on T2-weighted images like the normal prepartum placenta. Enhancing tissue may suggest the presence of chorionic and decidual tissue as well as vascularized granulation tissue (8).

However, in the setting of acute postpartum hemorrhage, CT can be the modality of choice to investigate the source of bleeding. On contrast-enhanced CT images RPOC can be seen as enhancing soft tissue in the endometrial cavity associated with variable degrees of myometrial thinning (Fig. 12) (8, 9). CT findings are not characteristic and sometimes cannot help to discriminate between RPOC and endometritis (9).

#### Conclusion

With the increasing use of CT as the modality of choice during the immediate post-CS period, familiarity with the normal and abnormal postsurgical findings has become a necessity to avoid misdiagnosis. Unfortunately, CT features of normal CS scar display large variability and there is an important overlap between normal and abnormal postsurgical findings. In this setting, the radiologists should know that some findings such as the presence of myometrial interruption and small hematomas in unusual locations (bladder flap hematoma, subfascial hematoma) do not represent pathologically significant findings, whereas other conditions such as major hematomas, uterine dehiscence, and uterine rupture have to be identified as significant complications. Moreover, given the absence of standardized imaging findings for interpretation of uterine dehiscence and rupture, the radiologic suggestion of complications must be evaluated in view of the clinical setting.

#### **Conflict of interest disclosure**

The authors declared no conflicts of interest.

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