CT in the assessment of peripartum complications

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<th>Poster No.:</th>
<th>C-2046</th>
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<td>Congress:</td>
<td>ECR 2014</td>
</tr>
<tr>
<td>Type:</td>
<td>Educational Exhibit</td>
</tr>
<tr>
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<tr>
<td>Keywords:</td>
<td>Obstetrics (Pregnancy / birth / postnatal period), CT, Contrast agent-intravenous, Obstetrics</td>
</tr>
<tr>
<td>DOI:</td>
<td>10.1594/ecr2014/C-2046</td>
</tr>
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Learning objectives

To review some abdomino-pelvic peripartum related complications documented by CT.
Background

The peripartum is the period shortly before, during, and immediately after giving birth and is usually confined to the last trimester of pregnancy until 6 months after delivery, encompassing the postpartum. The postpartum is the stage beginning immediately after the delivery of the infant and placenta and extending for about six weeks. The period after a spontaneous or elective termination is less well defined, but complications are often grouped into early complications occurring immediately or within the first days after the procedure, and delayed complications occurring beyond that time (1, 2).

Pregnancy remains an important source of mortality in young women in the 21st century with estimates of 400 deaths per 100,000 deliveries worldwide in the year 2005, totaling 536,000 maternal deaths, primarily in developing nations (3). More than three quarters of these deaths occur in the postpartum period (4). In addition to life-threatening complications, other less severe conditions are relatively common after birth or abortion, requiring hospitalization or additional procedures (5, 6). Moreover, we have seen a substantial growth of caesarean section in developed countries and its associated complications (7, 8).

Although the majority of peripartum related complications is clinically diagnosed and resolved, sometimes aided by ultrasound (performed by obstetrician), CT is being increasingly used. CT is of great value when US findings are equivocal or when they are insufficient to adequate characterization, and in the setting of a life-threatening illness. The fact that the worst complications are rare explains why most radiologists are not familiar with their CT findings.
Findings and procedure details

Uterine rupture during labor induction with stillborn

Uterine rupture is a catastrophic complication of pregnancy with a rare incidence of 0.73 per 10,000 deliveries (9, 10). It is defined as the disruption of all the layers surrounding the fetus, including the membranes, decidua, myometrium, and serosa (11). Uterine rupture may occur before, during, or shortly after labor (10, 12).

Predisposing conditions:

- previous uterine surgery (cesarean section, myomectomy, septoplasty, prior uterine curettage)
- excessively long or difficult labor, namely after prolonged induction with oxytocin or similar agents promoting smooth muscle contraction
- congenital uterine malformations
- persistent retroflexion due to adhesions ("trapped uterus")
- cornual implantation (10-13)

Patients usually present with sudden onset of severe abdominal pain; vaginal bleeding may also occur. Intraperitoneal hemorrhage is often severe, placing the mother at risk for hypovolemic shock. Maternal mortality varies from 2% to 20% and fetal mortality varies from 10% to 25% with good facilities (10).

Only a very short time interval for successful intervention exists once uterine rupture has occurred. If there is a clinical suspicion, uterine rupture is treated by immediate laparotomy, and imaging is not performed (12, 14). CT is often required for evaluation of more indolent cases (12).

CT findings:

- disruption of the uterine wall appearing as a low attenuation defect within the otherwise densely enhancing myometrium (15)
  - if the rupture occurs before the onset of labor, it is usually in the corpus area, either anteriorly or posteriorly
  - with advanced labor, the thinned lower uterine segment is the most vulnerable part of the uterus (10, 14)
Small bowel perforation during cesarean section

In cesarian section, both the small bowel and the rectosigmoid colon are at risk for injury. Further complications of bowel injury include perforation, peritonitis, abscess formation, bowel obstruction, and fistula formation (16-18).

Risk factors for bowel injury during gynecologic surgery:
- adhesions from previous surgery
- previous radiation therapy
- pelvic inflammatory disease
- endometriosis (19)

CT findings:
- excess intraperitoneal air or persistent pneumoperitoneum after the first postoperative week is an indicator of bowel perforation
- loculated fluid collections with air-fluid levels and extravasation of oral contrast material may be seen (19) (Figure 2)

Ureter rupture and ureterovaginal fistula related to urgent hysterectomy

Peripartum hysterectomy is associated with much higher rates of intraoperative bleeding, urinary tract injuries, infections, and the need for additional operation or procedures (20, 21). Urologic complications, namely ureteral lesions, are a major concern of total hysterectomies (19). This is related to the fact that the ureters are in close proximity to the lateral edge of the cervix in women with normal pelvic anatomy (19).

Ureteral urine leaks most commonly occur as a result of iatrogenic injury during gynecologic, obstetric, urologic, colorectal, general, or vascular surgery (22-24); gynecologic surgery accounts for more than half of all iatrogenic injuries (25).

Risk factors for urinary tract injury during gynecologic surgery:
- adhesions from previous surgery
- previous radiation therapy
- pelvic inflammatory disease
- endometriosis (19)

Patients may present with flank or abdominal pain, elevated serum blood urea nitrogen and creatinine levels, vaginal urinary leakage, fever, or other nonspecific symptoms. Hematuria is an unreliable indicator of ureteral trauma and may be absent in many patients (25, 26).

The diagnosis of ureteral injuries may readily be accomplished with retrograde or antegrade pyelography or with CT that includes unenhanced, corticomedullary, and delayed imaging. Delayed phase CT scans (obtained 5-20 minutes after contrast material injection) are optimal for demonstrating ureteral urine leaks. Coronal and sagittal three-dimensional reformatted CT images are essential for further characterization of the extent of injury to the ureter (27).

CT findings:
- contrast extravasation from the ureter or partial or complete ureteral obstruction in patients with ureteral injury
- urinary ascites or urinoma may also be seen; a high index of suspicion should be maintained in postoperative patients with intra-abdominal fluid collections to accurately assess the urinary tract for urine leaks and to characterize any fluid collections (26) (Figure 3)

Ureteral injuries may heal without complications or may progress to urinoma, ureteral stricture and obstruction, and ureterovaginal or vesicovaginal fistula (26). A fistula is defined as an abnormal communication between two epithelial surfaces resulting from an injury or disease. It connects an abscess cavity or hollow organ to the body surface or to another hollow organ. Fistulas can occur secondary to bowel or urinary tract injury. Extraluminal extension of contrast material into the vagina confirms an ureterovaginal fistula and is better depicted with CT urography (19).

Women with fistula between urinary and genital tracts present with dribbling of urine from the vagina. Women primarily present with intermittent urine leakage or incontinence, cyclical hematuria and apparent amenorrhea.
Diagnostic workup includes conventional fluoroscopic barium studies, IVU, retrograde pyelography, and fistulography, as well as CT and MR imaging. The appropriate imaging method depends on the anatomic location of the fistula. Axial thin-section CT scans with multiplanar reformatted images are helpful in the detection of fistulas and their morphologic features (26). MR imaging has an advantage in delineating complex fistulous tracts because of its multiplanar capability. The diagnosis of uterero-vaginal fistula may be established radiographically with vaginography, excretory urography, and retrograde pyelography, as well as with CT and MR imaging (28).

CT findings:

- extravasation of contrast material in a collection outside the ureter, eventually draining into the vaginal cavity
- the presence of an obstructed ureter in patients with vaginal drainage may also suggest the diagnosis

Dehiscence of the uterine wound and pelvic abscess after cesarian section

The exclusion of a suspected postpartum complication is further problematic because the postpartum uterus has a variable appearance, and there is significant overlap between the normal and abnormal uterus. In the case of endometritis suspicion, the presence of gas within the cavity of the endometrium, which can also be a normal finding, makes it a challenging diagnosis (29). Endometritis, or infection of the uterine decidua, is the most common complication after cesarean section, and occurs more often than after vaginal delivery (30, 31). Endometritis can be further complicated by dehiscence of the cesarian wound, or even uterine rupture, and/or pelvic abscess.

Analogous to infectious dehiscence of a fascial incision or surgical anastomosis, the myometrial incision can become infected and dehisce, resulting in infective uterine rupture (29). Uterine rupture is the most severe potential complication of cesarean delivery and is defined as separation of all layers of the uterine wall, with abnormal communication between the uterine cavity and the peritoneal cavity (32). If only the myometrium is ruptured, it is defined as uterine dehiscence (10). This condition is rare, with an estimated incidence of one in every 700-2400 cesarean births (33).

Abscess formation can occur after delivery most commonly in patients who underwent a cesarean delivery. Infection usually occurs in the region of the incision; however, it also can occur in the parametrium (34).

Risk factors for cesarean section wound dehiscence:

- obesity
- diabetes mellitus
- previous cesarean section
- retroflexed gravid uterus
- prolonged labor (35-36)

Risk factors for infection and abscess:
- hematoma
- bowel injury
- urinary tract injury

Although CT features of uterine dehiscence were considered nonspecific, some authors have shown that using multiplanar reformatted sequences (especially using the reformatted images that are perpendicular to the plane of incision), CT could be a good initial imaging modality (37). Even so, in cases of suspected uterine dehiscence, contrast-enhanced pelvic MRI appears to be superior because of greater soft-tissue contrast (29).

CT findings:
- the presence of gas within the uterine defect extending from the endometrial cavity to the extrauterine parametrium in association with hemoperitoneum increases the likelihood of rupture in the appropriate clinical setting (32)
- although smaller bladder wall hematomas have been seen in normal cesarean section, the presence of large hematomas (> 5 cm) should be considered abnormal and highly suspicious for uterine dehiscence (29, 38)
- a true dehiscence is usually associated with a large hematoma or abscess (19)
- free fluid, pleural effusion, bowel distention, and intrahepatic abscess (39), are common associated nonspecific findings

Findings that have been described on MRI include:
- a lack of apposition of the endometrium and serosa at the incision site and discontinuity of the myometrium with associated fluid collection, hematoma, or regions of low signal intensity suggestive of gas
CT findings of pelvic abscess:
- thick-walled, rim-enhancing, fluid-filled structure with adjacent inflammatory stranding
- the presence of gas inside the collection is specific for abscess (39)
- an air - fluid level and internal septations may be present (34, 41, 42)

Ovarian vein thrombosis

Ovarian vein thrombosis has a prevalence of 1 per 600 deliveries (43). It is frequently unilateral and the right ovarian vein is involved in up to 90% of cases, as the left vein may be protected by retrograde flow from the renal vein which prevents bacterial-laden blood from traveling up this vessel (12, 44).

Etiology:
- post- partum complication (most common)
- pelvic inflammatory disease
- chemotherapy
- malignant tumours
- pelvic surgery
- trauma
- inflammatory bowel disease(12)

Contributive factors in pregnancy:
- at term, the capacity of the ovarian vein increases 60 times (45); after delivery, venous velocity in the ovarian veins declines sharply, which causes partial collapse of the vein and creates substantial venous stasis, predisposing to thrombosis
- minimal adventitial sheaths in the ovarian veins allows their expansion during pregnancy; however, this also makes them vulnerable to compression from external sources; the enlarging uterus during pregnancy compresses the veins, causing venous stasis(10, 12)
- increased levels of fibrin and the other coagulation factors, as well as to systemic up-regulation of plasma pro-thrombotic mediators define a pro-thrombotic state at
pregnancy, which requires 4 weeks to return to normal population levels after delivery (46).

Patients present with fever and pain in the right lower quadrant or flank, and a tender abdominal mass is palpable in one-third to two-thirds of the patients (10). Thrombophlebitis may complicate a bland thrombus, particularly in post-partum patients with endometritis (47, 48).

Differential diagnosis (49):
- appendicitis
- broad-ligament phlegmon or hematoma
- torsion of the ovary
- torsion of an ovarian cyst
- urolithiasis
- pyelonephritis
- degenerating leiomyoma
- pelvic cellulitis
- pelvic or abdominal abscess

Overlying bowel gas usually obscures the pelvic portion of the ovarian vein. Although the abdominal portion is more amenable to ultrasound evaluation, CT or MR imaging is usually required to clarify de clinical suspicion (13, 37).

CT findings:
- an enlarged ovarian vein with low-density thrombus in the center of the lumen, surrounded by an enhancing vessel wall
- a surrounding inflammatory reaction, seen as ill-defined soft-tissue density also may be present
- following the course of the ovarian vein from the pelvis to the inferior vena cava or left renal vein helps to distinguish it from the ureter or appendix
- perivascular stranding associated with an enlarged gonadal vein helps to support the diagnosis of thrombophlebitis and distinguish it from bland thrombus

**Pelvic hematoma after urgent hysterectomy**

Uterine and periuterine hematomas can result from rupture of the uterine corpus, upward extension of a cervical laceration with tearing of a major vessel, or extension of a cesarean section incision laterally or inferiorly with injury to the uterine artery or branches (50).

Also, note that cesarean delivery is associated with the development of small bladder flap hematomas and subfascial hematomas in up to 50% of patients. Rectus sheath hematomas and intraperitoneal pelvic hematomas occur less frequently (34).

**CT findings:**

- fluid-attenuation collection (slightly hyperattenuating if recent)

**Fibroid degeneration**

Fibroids are benign smooth muscle tumours, sensitive to estrogens. They can suffer rapid growth during pregnancy, leading to "red degeneration", the most common type of degeneration during this period. It occurs if a leiomyoma outgrows its blood supply with resulting hemorrhage (14).

The growth of fibroids is governed by competing hormonal and vascular factors. Estrogen receptors are thought to be at higher concentrations on myoma cells than in normal myometrium, so the elevated estrogen level in early pregnancy promotes growth (13). Additionally, uterine stretching may interfere with arterial supply to fibroids, promoting infarction and cystic degeneration in later pregnancy (13).

Ultrasound is often the initial diagnostic imaging modality for suspected complications of fibroids, which usually present with pelvic pain.

**Ultrasound findings:**

- circumscribed masses with cystic spaces or heterogeneous echogenicity

- circumferential vascularity at color-Doppler; necrotic areas will show absence of flow (14, 51)
CT findings:
- a cystic appearance of a fibroid mass, with reduced enhancement and hypodense areas (51)

Fibroid degeneration can often be difficult to distinguish from cystic ovarian masses on CT and MRI is often needed to distinguish between them. Multiplanar views can enable localization of fibroids and can make it possible to distinguish fibroids from ovarian masses.

MR findings:
- cystic change and areas of non-enhancement
- in cases of red degeneration, MRI appearances show high signal intensity centrally within the fibroid on T1-weighted images consistent with blood, with reduced signal at the periphery on T2-weighted images secondary to hemosiderin deposition. There may be heterogeneous signal intensity on T2, with no enhancement post-gadolinium administration (52, 53).
Fig. 1

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Fig. 2

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Fig. 3: Ureter rupture (a) and uretero-vaginal fistula (b-d) after urgent hysterectomy in a patient with postpartum hemorrhage caused by uterine atony.

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Fig. 4: Dehiscence of the uterine wound after cesarian section.

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Fig. 5: Cesarian-section dehiscence in other patient.

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**Fig. 6**: Abdominopelvic abscess in a 24-year-old woman presenting with fever and abdominal pain who had undergone cesarean section.

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Fig. 7: Another patient with post-cesarian section abscesses.

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Fig. 8: Right ovarian vein thrombosis in a 32-year-old woman 8 days after delivery. She presented to the emergency department complaining of right lower abdominal pain.

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Fig. 9: Pelvic hematomas after post-partum urgent hysterectomy.

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Fig. 10: Cystic fibroid degeneration. This patient presented to the emergency department 3 days after a vaginal delivery with lower abdominal pain.

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Conclusion

Radiologists should be aware of the main complications of peripartum period, since some of them present with typical CT findings, which will allow a timely diagnosis.


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