Radiología 63 (2021) 22–31

RADIOLOGÍA

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RADIOLOGY THROUGH IMAGES

Puerperal complications: Pathophysiological mechanisms and main imaging findings☆

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Received 7 April 2020; accepted 24 August 2020

KEYWORDS
Computed tomography;
Puerperium;
Thrombosis;
Eclampsia;
Endometritis

Abstract
Objective: Puerperium is the period during which the physiological changes that have taken place during pregnancy revert and the uterus involutes until it reaches its normal size. This is a period of intense systemic changes, and diagnosing complications in this period is a challenge for both gynecologists and radiologists.

This paper reviews the complications that can occur during puerperium, classifying them according to the pathophysiological mechanisms involved: the prothrombotic state, hemodynamic and hormonal changes, rapid uterine growth, changes associated with endothelial damage (preeclampsia, eclampsia, and HELLP syndrome), and postoperative complications in patients undergoing cesarean sections.

Conclusion: Puerperal complications represent a diagnostic challenge. Understanding the pathophysiological mechanisms underlying these complications is fundamental for choosing the most appropriate imaging technique to ensure the correct diagnosis in each case.
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PALABRAS CLAVE
Tomografía computarizada;
Puerperio;
Trombosis;
Eclampsia;
Endometritis

Complicaciones del puerperio: mecanismos fisiopatológicos y principales hallazgos radiológicos asociados

Resumen
Objetivo: El puerperio es el periodo en el que los cambios fisiológicos que han tenido lugar durante el embarazo revierten y el útero involuciona hasta recuperar su tamaño normal. Se trata de un periodo de intensos cambios sistémicos, y el diagnóstico de las complicaciones asociadas constituye un reto tanto para el ginecólogo como para el radiólogo.

☆ Please cite this article as: García Prieto J, Alonso Sánchez J, Martínez Chamorro E, Ibáñez Sanz L, Borruel Nacenta S. Complicaciones del puerperio: mecanismos fisiopatológicos y principales hallazgos radiológicos asociados. Radiología. 2021;63:22–31.

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En este trabajo se revisan las complicaciones que pueden acontecer, y se clasifican en función de su mecanismo fisiopatológico: el estado protrombótico, los cambios hemodinámicos y hormonales, el rápido crecimiento uterino, las alteraciones asociadas al daño endotelial (preeclampsia, eclampsia y síndrome de HELLP) y las complicaciones posquirúrgicas de la cesárea.

Conclusión: Las complicaciones del puerperio son un reto diagnóstico. Comprender el mecanismo fisiopatológico subyacente es fundamental para el diagnóstico y la elección de la técnica de imagen más apropiada en cada caso.

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Introduction

Puerperium, or the postpartum period, is the period from birth to approximately 6–8 weeks thereafter, in which the physiological changes that occurred during pregnancy revert to their pre-pregnancy state and the uterus returns to its normal size.[1] It is a time of dramatic systemic changes, and the diagnosis of associated complications represents a challenge for gynaecologists and radiologists alike.

This period features significant overlap between normal and pathological findings, such that any diagnosis of complications in a patient should be consistent with the patient's signs and symptoms.

Normal findings

Under normal circumstances, in puerperium, the uterus is enlarged with hypodense or hyperdense contents in the uterine cavity on computed tomography (CT) in relation to fluid or blood clots, respectively, which will be heterogeneous echogenic material on ultrasound. Gas may also be seen in up to half of patients, with no pathological significance after birth, especially if the patient has had a Caesarian birth.[1,2]

During pregnancy, there is increased vascularisation which will persist during the first few weeks of puerperium. CT may reveal prominent vascular structures, contrast addition images or perfusion abnormalities. On Doppler ultrasound, the uterus will have a hypervascular appearance.[1,2]

It is also important to be familiar with the findings that can be expected following a Caesarean birth. The most commonly used surgical technique is the Pfannenstiel technique. This consists of a low transverse incision which may be identified between the bladder and the uterus as an area that is slightly hypoechoic on ultrasound and hypodense on CT, in the low anterior aspect of the uterus. It should not be interpreted as uterine dehiscence in the absence of clinical suspicion.[3]

Striation of the periuterine fat or subcutaneous cellular tissue or even a small amount of free fluid secondary to the surgical procedure may also be found.[3]

Collections in the prevesical and vesicouterine spaces are not considered clinically significant if they are smaller than 4 cm.[3]

It should be borne in mind that *in puerperium there is overlap between normal and pathological findings on imaging. It is important to be familiar with physiological findings and to consider signs and symptoms when diagnosing complications.*

Complications

This paper reviews the complications that may occur in puerperium, which are classified by the underlying pathophysiological mechanism: prothrombotic state, haemodynamic and hormonal changes, rapid uterine growth, abnormalities associated with epithelial damage (pre-eclampsia; eclampsia; and haemolysis, elevated liver enzymes, low platelet count [HELLP] syndrome) and the postoperative complications of a Caesarian birth.

Increased clotting

Pregnancy is a prothrombotic state in which clotting factors gradually increase to protect the woman from major haemorrhage during birth. This increases the risk of suffering from venous or arterial thrombosis at different levels.[1,4]

Ovarian vein thrombosis (Figs. 1 and 2)

Ovarian vein thrombosis is a complication that occurs in 0.05%–0.18% of all births,[4] with a higher prevalence on the right side, which is involved in up to 90% of cases (10% of cases feature bilateral involvement).[5] Patients normally present abdominal pain and fever; therefore, early diagnosis is important for the prevention of infectious complications (pelvic septic thrombophlebitis). Ultrasound may be used as a first diagnostic imaging approach, although its role is limited, and CT is considered the technique of choice, demonstrating an increase in the calibre of the vein with the absence of endoluminal contrast and peripheral uptake. The ovary may also be enlarged.[4,6]

Figure 1 Right ovarian vein thrombosis. A 34-year-old woman on the second day of the postpartum period, with fever and pelvic pain. Ultrasound (a) shows a hypoechogenic tubular structure with increased echogenicity of adjacent fat. Axial (b) and coronal (c) computed tomography images show the thrombosed, enlarged ovarian vein from the pelvis to the vena cava (arrows) and the enlarged puerperal uterus with hypodense contents (*).

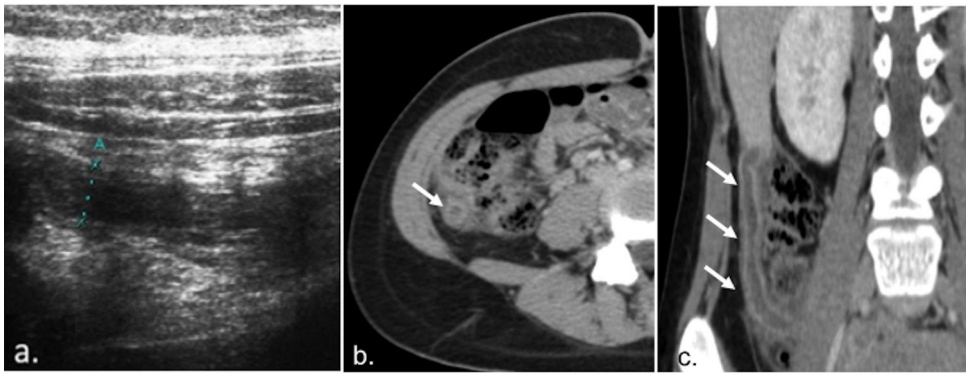

Figure 2 Accessory ovarian vein thrombosis in a 15-year-old puerperal woman with fever and pain in her right flank, with clinical suspicion of acute appendicitis. Ultrasound (a) shows a hypoechogenic tubular structure in the right iliac fossa diagnosed as appendicitis. Computed tomography (b–c) revealed bilaterally thrombosed ovarian veins (arrows) with a retrocaecal path on her right flank.

Pulmonary thromboembolism

The risk of pulmonary thromboembolism (PTE) in the first 3 months after birth is 30 times higher compared to non-puerperal women of the same age.[7] D-dimers may be normally elevated in this period. CT angiography of the pulmonary arteries should be performed if PTE is suspected.[2,4]

Cerebral venous sinus thrombosis

There is an increased risk, especially in the first 2 weeks after birth.[6] Symptoms range from headache to focal neurological deficit or coma.[8] CT without and following administration of intravenous contrast (IVC) may be considered, but the most sensitive test for diagnosing the condition

Figure 3 A 38-year-old woman on the second day following an emergency Caesarian birth due to pre-eclampsia, with signs and symptoms of sudden-onset epigastric pain. A CT angiogram of the chest was performed due to suspicion of pulmonary thromboembolism. The last slice from the CT of the chest (a) shows dissection of the descending aorta (circle). The study was complemented with CT of the aorta (b) which confirmed Stanford type B aortic dissection and showed the puerperal uterus (*).

and assessing the extent of the complications is magnetic resonance imaging (MRI).[9]

A hypercoagulable state may cause thrombosis at any other level; in addition, there is an increased risk of *cerebral infarction* stemming from arterial thrombosis[9] or embolic thrombosis caused by dissections following prolonged labour, due to cardiovascular disease or resulting from postpartum cardiomyopathy (a rare dilated cardiomyopathy).[10]

It should be borne in mind that *pregnancy and puerperium are prothrombotic states and that there is an increased risk of thrombosis at different levels. Ovarian vein thrombosis is one of the most common complications.*

Haemodynamic changes

During pregnancy, total blood volume increases to support the rapid growth of the foetus and the placenta and to protect the mother from blood loss during birth. It also increases cardiac output and heart rate.[11]

Acute pulmonary oedema

The incidence of acute pulmonary oedema in women after birth is estimated at 0.8:1000. It is important to consider this possibility for an early diagnosis with a chest X-ray and immediate treatment, thus preventing diagnostic delays with other options such as a CT scan.[12]

Aortic dissection (Fig. 3)

Aortic dissection is a rare complication, but diagnostic delays are potentially fatal. Women with Marfan syndrome are at elevated risk, but it may occur in healthy women with no predisposing factors. CT with IVC is the essential diagnostic tool. In cases of suspected acute aortic syndrome, a baseline CT scan must be performed to detect intramural haematoma, and a CT scan with IVC must be done to detect aortic dissection.[13]

Intracranial haemorrhage (Fig. 4)

Intracranial haemorrhage is a rare complication associated with a high mortality rate. A CT scan of the head is the first-line option for detecting haemorrhage, and IVC injection is recommended to rule out underlying lesions such as aneurysms, arteriovenous malformations and tumours.[9]

It should be remembered that *some complications, such as aortic dissection and intracranial haemorrhage, are rare but potentially fatal. It is important to take them into consideration to avoid diagnostic delays.*

Infections

The rapid increase in the size of the uterus causes compression of neighbouring organs and increases the risk of infections. The body is in a pro-inflammatory state, and

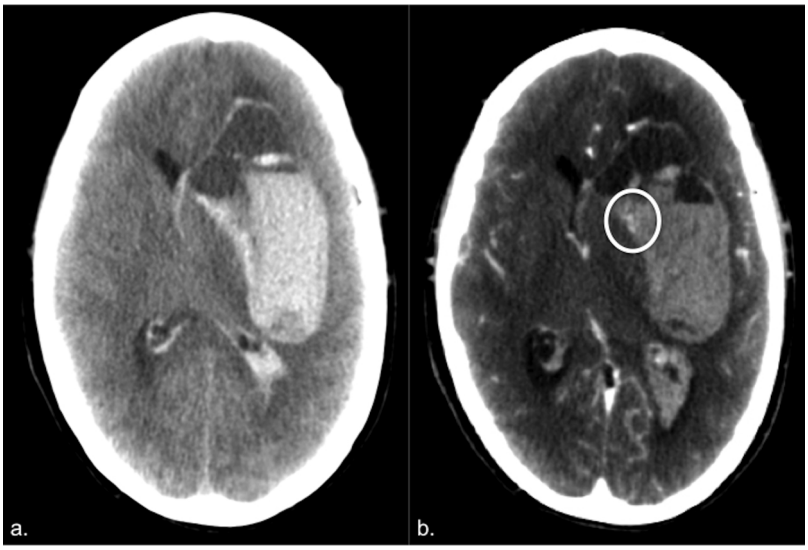

Figure 4 Intraparenchymal haematoma with active bleeding. A 41-year-old woman on the third day of the postpartum period, who developed headache and right hemiparesis. A CT scan of the head without intravenous contrast (a) identifies a large left-hemisphere intraparenchymal haematoma. Following administration of contrast, extravasation of contrast was seen in the sinus of the haematoma (b, circle) as a sign of active bleeding.

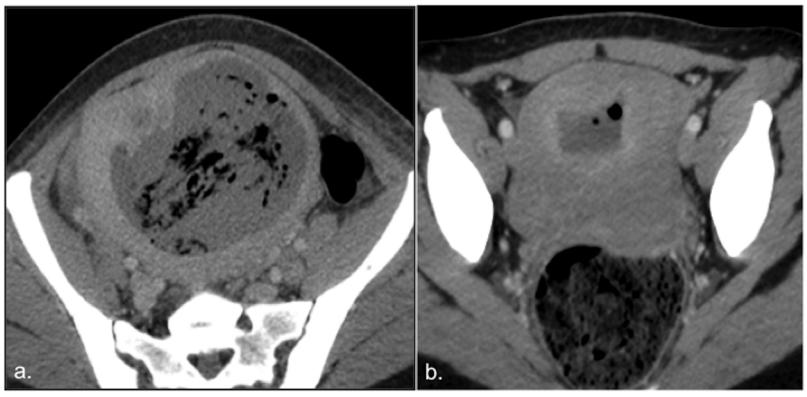

Figure 5 Endometritis. A 37-year-old woman in the second week of puerperium with persistent fever and pelvic pain. Computed tomography (a) shows an enlarged uterus with abundant hypodense contents and gas — more than expected for the second week of the postpartum period. Correlation with signs and symptoms is important. Image ''b'' belongs to another patient, who is asymptomatic. Hypodense contents and gas bubbles in are seen in the endometrial cavity as a normal finding.

leukocytosis is a common finding in the absence of infection, acting as a confound for diagnostic suspicion.[14]

A CT scan of the abdomen and pelvis with IVC is the technique of choice, with a longer delay in image acquisition than in the portal phase (usually 90 s) to detect possible complications such as gonadal vein thrombosis and acute pyelonephritis.

Endometritis

This is the most common cause of persistent fever in puerperium, with an incidence of up to 30%, especially in cases of Caesarian birth.[15] Imaging findings overlap with normal findings: increased uterine size, endometrial contents and gas. Therefore, clinical suspicion is essential for diagnosis (Fig. 5). Ultrasound may be used to assess the endometrial cavity, but the infection may spread and become complicated with the formation of abscesses or peritonitis (Fig. 6); therefore, in these cases, the diagnostic technique of choice is a CT scan.[1,2,16]

Appendicitis

This is not a common cause of fever in puerperium, and its diagnosis may pose a challenge: the patient's pain may be related to the surgical procedure she recently underwent or may develop in the right hypochondrium due to the displacement caused by the size of the uterus. Ultrasound may be used as a first-line diagnostic option; CT should be used if ultrasound is inconclusive.[2]

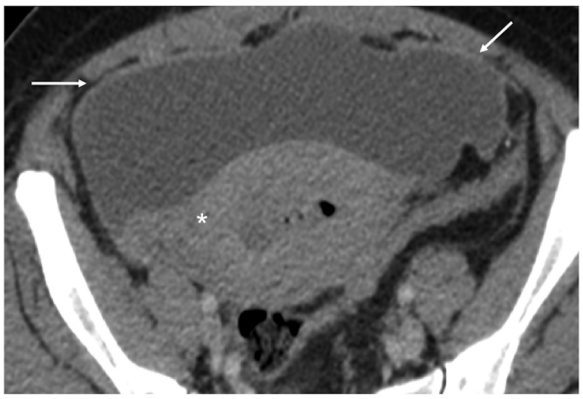

Figure 6 Peritonitis as a complication of endometritis. A 34-year-old woman on day 7 of the postpartum period who had persistent fever despite antibiotic treatment. CT with intravenous contrast shows loculated ascites and peritoneal enhancement (arrows). Enlarged uterus with contents and gas inside (*).

Pyelonephritis (Fig. 7)

Pyelonephritis is a common cause of fever in the postpartum period. Compression of the ureters due to the increased size of the uterus and high progesterone levels slow down renal excretion, which is a predisposing factor for infection.[17] CT is more sensitive than ultrasound for diagnosis, with findings such as enlarged kidneys, poorly defined areas of parenchymal hypouptake and microabscesses. Both may be used for detecting complications such as pyonephrosis or abscesses.[2] Ultrasound with contrast should also be considered as a diagnostic alternative to CT, thus preventing radiation exposure in young women. Areas of nephronia are seen as hypoechoic areas in the parenchymal phase, and abscesses are seen as anechoic areas which may be associated with peripheral or septal enhancement.[18]

Septic arthritis of the pubic symphysis

This is an uncommon complication with an insidious clinical presentation, hence diagnosis may be delayed. Prolonged labour and instrumental delivery are predisposing factors.

Figure 7 Pyelonephritis in a 42-year-old puerperal woman with pain in her right flank and fever. CT with intravenous contrast in the excretory phase shows a striated nephrogram and delayed excretion of contrast in the left kidney.

Imaging tests are essential for diagnosis, and MRI is the best technique.[19] CT may reveal a hypodense collection with peripheral uptake in the pubic symphysis (Fig. 8).

Pre-eclampsia, eclampsia and HELLP syndrome

These abnormalities are related to hypertension and secondary endothelial damage during pregnancy and puerperium. Diagnosis is based on elevated blood pressure and proteinuria, and imaging is used to detect associated complications.[20]

Hepatic rupture

Spontaneous hepatic haemorrhage is a rare but potentially serious complication of HELLP syndrome. CT is the imaging modality of choice, since it permits diagnosis of subcapsular haematomas, hepatic infarction and hepatic rupture with associated haemoperitoneum.[20] (Figs. 9 and 10). Ultrasound is useful in patients who present haemorrhagic shock, due to its speed, availability and detection of subcapsular and intrahepatic haematomas as hypoechogenic collections with internal echoes.

Figure 8 Septic arthritis of the pubic symphisis in a 26-year-old woman on the sixth day after giving birth to twins. Axial (a) and coronal (b) CT images show a hypodense collection with peripheral enhancement (arrows) in the pubic symphisis and an enlarged puerperal uterus (*). Microbiology testing revealed growth of *Escherichia coli*.

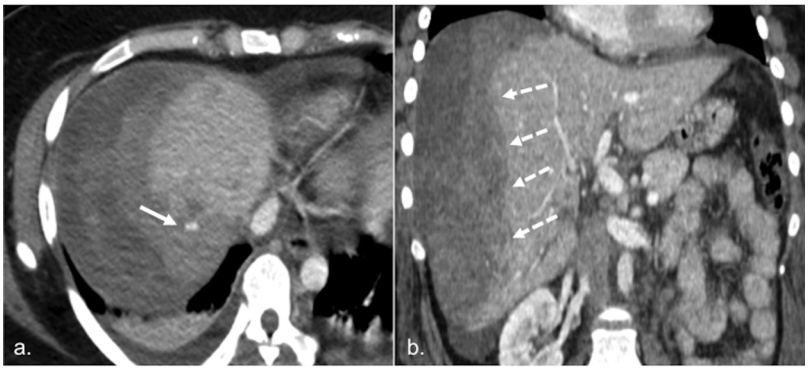

Figure 9 Hepatic rupture in a 28-year-old woman who developed acute abdominal pain on the first day following an emergency Caesarian birth in a context of pre-eclampsia. CT shows a large subcapsular haematoma (b, dotted arrows) with foci of active bleeding (a, arrow).

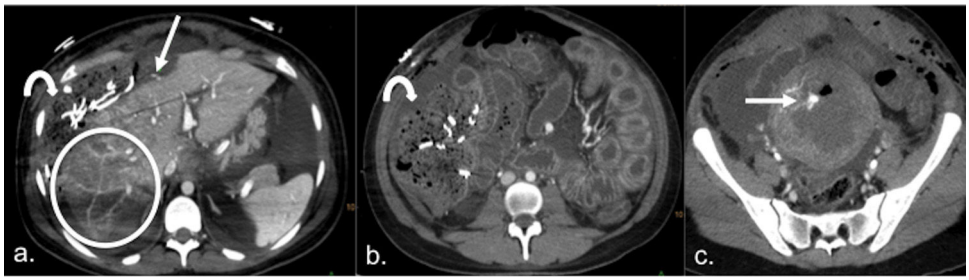

Figure 10 Hepatic rupture in a 26-year-old woman who had an emergency Caesarian birth due to pre-eclampsia and an emergency operation due to haemorrhagic shock. Postoperative computed tomography shows abundant haemoperitoneum and multiple hepatic (a, straight arrow) and uterine (c, straight arrow) foci of active bleeding. It also shows perihepatic haemostasis matter (b, c, curved arrows), hypodensity of the parenchyma consistent with ischaemia (a, circle) and significant oedema of intestinal loops (b).

Posterior reversible encephalopathy

Posterior reversible encephalopathy (PRES) typically presents with headache, cortical blindness and seizures. CT may show hypodense areas in the posterior region, but MRI is the technique of choice. It identifies hypointense posterior areas on T1-weighted sequences and hyperintense ones on T2-weighted sequences with no restricted diffusion (Fig. 11). The basal ganglia and brainstem may also be affected. Angiography demonstrates vasospasm. Complete resolution on follow-up imaging is characteristic.[9]

It should be remembered that *the diagnosis of pre-eclampsia, eclampsia and HELLP syndrome is based on laboratory testing criteria. Imaging is used for detecting potentially serious associated complications such as hepatic rupture.*

Postoperative complications

One in four births in Spain is a Caesarian birth.[21] Caesarian births may be associated with a wide range of complications; some are specific and related to the surgical procedure.[3]

Uterine rupture and dehiscence

Unlike uterine rupture, in uterine dehiscence, the serous layer is intact, meaning that major haemorrhage is uncommon (Fig. 12). However, in practice, it may be very difficult for the radiologist to distinguish these conditions from each other and from normal postpartum findings. If pain is present, a myometrium thinner than 2 mm[22] or a haematoma larger than 5 cm should be considered pathological.[23] MRI is the most sensitive technique for demonstrating uterine wall defects, but in emergency situations, CT is the technique of choice.[2,3,6]

Fistula

Formation of a fistula between the bladder or rectum and the genital tract (Fig. 13) may result from prolonged labour or a surgical complication of a Caesarian birth. In the presence of urinary symptoms, CystoCT is the technique of choice. If there is faecaloid matter in the vagina, it is advisable to perform the CT scan with endorectal contrast for a better diagnosis.[2]

Ureteral injury

This is an uncommon complication (less than 0.1%) of Caesarian birth. Strong clinical suspicion is needed to optimise

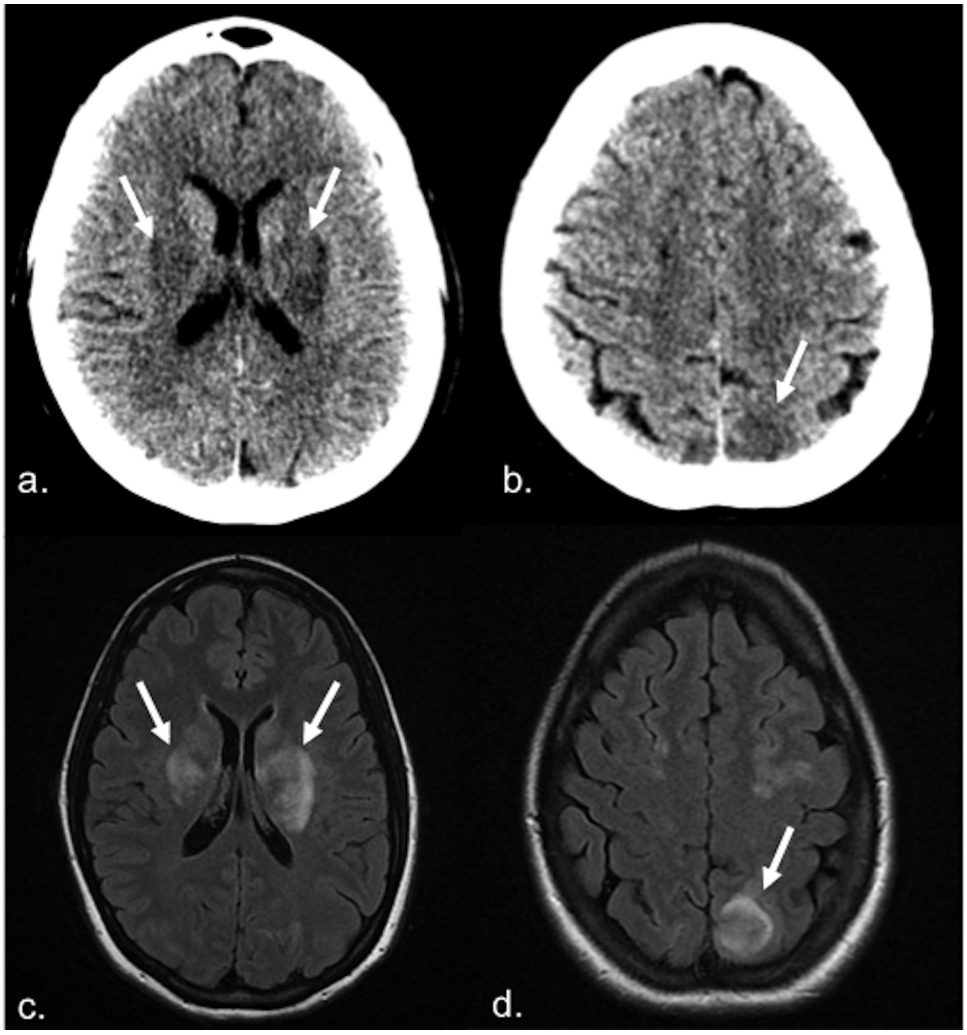

Figure 11 Posterior reversible encephalopathy syndrome (PRES) in a 37-year-old puerperal woman with headache. CT (a and b) shows hypodense areas in the basal and posterior parietal cortical ganglia (arrows). MRI FLAIR images (c and d) correspond to hyperintense areas (arrows), which presented no restricted diffusion (no image shown).

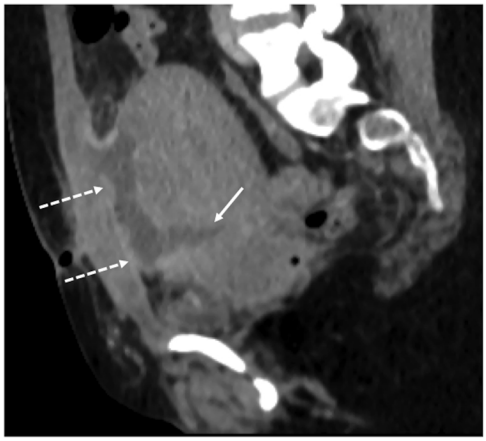

Figure 12 Uterine dehiscence in a 35-year-old woman on the fourth day following a Caesarian birth with persistent fever and pelvic pain. CT images revealed a preuterine collection (dotted arrows) continuous with solution of continuity with the anterior aspect of the uterus, in the area of the Caesarian scar (arrow).

the diagnostic technique and perform a CT scan with intravenous contrast in the nephrographic and excretory phases[2] (Fig. 14).

Conclusion

Complications in puerperium represent a clinical and radiological diagnostic challenge. Understanding the pathophysiological mechanism aids in understanding the different complications, selecting the most suitable imaging technique in each case and detecting key findings for diagnosis.

Authorship

1. Responsible for study integrity: JGP.
2. Study concept: JGP.
3. Study design: JGP.
4. Data analysis and interpretation: JGP, JAS, EMC, LIS and SBN.
5. Statistical processing: N/A.

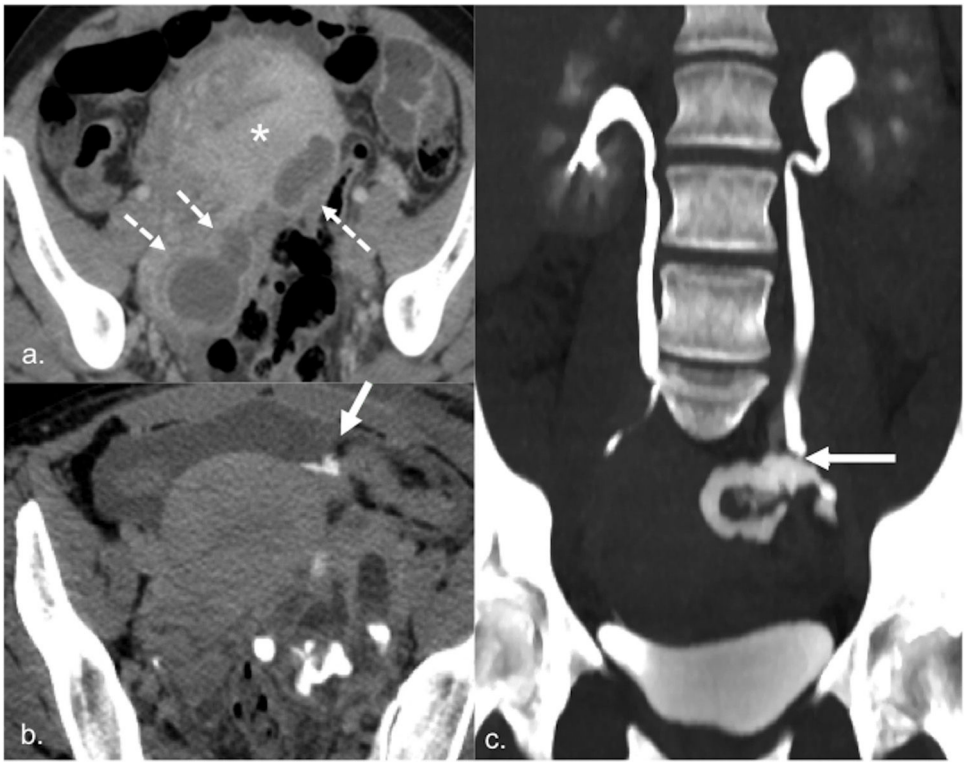

Figure 14 Post-Caesarian pelvic abscesses and ureteral damage. (a) Pelvic abscesses in contact with the posterior uterine wall (dotted arrows) and enlarged puerperal uterus with perfusion disorders (*) in a 35-year-old woman on the fifth day of puerperium. The abscesses were surgically drained, and the postoperative CT scan (b) shows extravasation of contrast in the excretory phase which fills the fluid collections (arrow). The coronal reconstruction (c) identifies the injury of the left ureter (arrow).

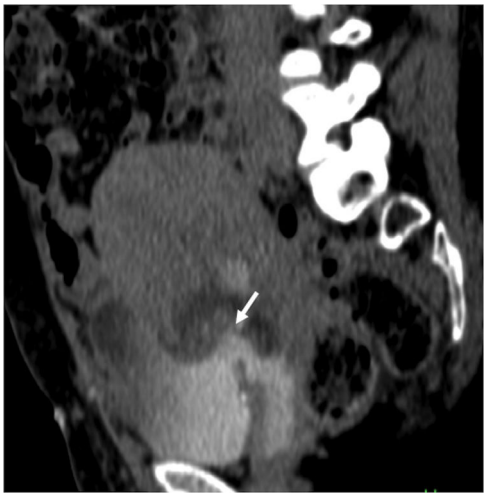

Figure 13 Post-Caesarian vesicovaginal fistula in a 32-year-old woman. Sagittal reconstruction from CystoCT shows a defect in the uterine wall (arrow), an opening between the bladder and the genital tract filled with urinary contrast.

6. Literature search: JGP, JAS, EMC, LIS and SBN.
7. Drafting of the article: JPG, JAS, EMC, LIS and SBN.
8. Critical review of the manuscript with intellectually significant contributions: JAS, EMC, LIS and SBN.
9. Approval of the final version: JGP, JAS, EMC, LIS and SBN.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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