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PICTORIAL ESSAY

CME

Contrast Material Extravasation: Appearances on Helical Computed Tomography

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ABSTRACT

Contrast material extravasation on a computed tomography image invariably indicates disruption of vascular structures, bowel, or the urinary tract. The pattern of contrast material extravasation often allows exact anatomic localisation of the site of haemorrhage or perforation and contributes to effective intervention. In this pictorial essay, the helical computed tomography appearances of contrast material extravasation are highlighted with specific features that might indicate the cause and site of extravasation.

Key Words: *Contrast media; Extravasation of diagnostic and therapeutic materials; Tomography, spiral computed*

INTRODUCTION

Contrast material extravasation (CME) on a computed tomography (CT) image invariably indicates disruption of vascular structures, bowel, or the urinary system. The pattern of CME often allows exact anatomic localisation of the site of haemorrhage or perforation and contributes to effective intervention. Contrast media extravasation has been categorised as follows:

- vascular
  - traumatic
  - non-traumatic
- bowel
- urinary system.

COMPUTED TOMOGRAPHY TECHNIQUE

The contrast medium is usually non-ionic iohexol 120 to 150 mL. The scan rate is 2 to 3 mL/second using a power injector, with a scan delay of 60 to 70 seconds and slice collimation of 7 or 8 mm. Oral contrast administration is variable, but should be given if bowel injury/perforation is suspected. Sagittal and coronal reformats can be extremely useful to depict the exact site of contrast extravasation. These are particularly useful for surgeons to detect the anatomic location of a haemorrhage.

Delayed scans should be obtained routinely, at least for the kidneys and urinary bladder. If there is suspicion of venous haemorrhage, delayed scans should be taken as this is generally picked up in the delayed phase (especially for ruptured ovarian cysts with a large haemoperitoneum or pelvic fractures). Delayed scans are also useful to differentiate between a contained pseudoaneurysm and free extravasation; a pseudoaneurysm remains unchanged, whereas free extravasation increases in amount and density.

Although CT is useful for depicting vascular CME, a CT image is inherently limited by the lack of dynamic information, and therefore does not always predict the persistence or cessation of bleeding or accurately quantify the degree or rate of bleeding.

VASCULAR CONTRAST MATERIAL EXTRAVASATION

Vascular CME is a sign of vascular disruption (arterial or venous). Active CME from a vascular disruption is a life-threatening emergency. This sign occasionally occurs unexpectedly in a stable patient.

Arterial CME is a high-flow extravasation that appears in the early arterial phase as an area of high attenuation, isodense to the adjacent arteries. A jet of contrast-enhanced blood, a pool of contrast within a

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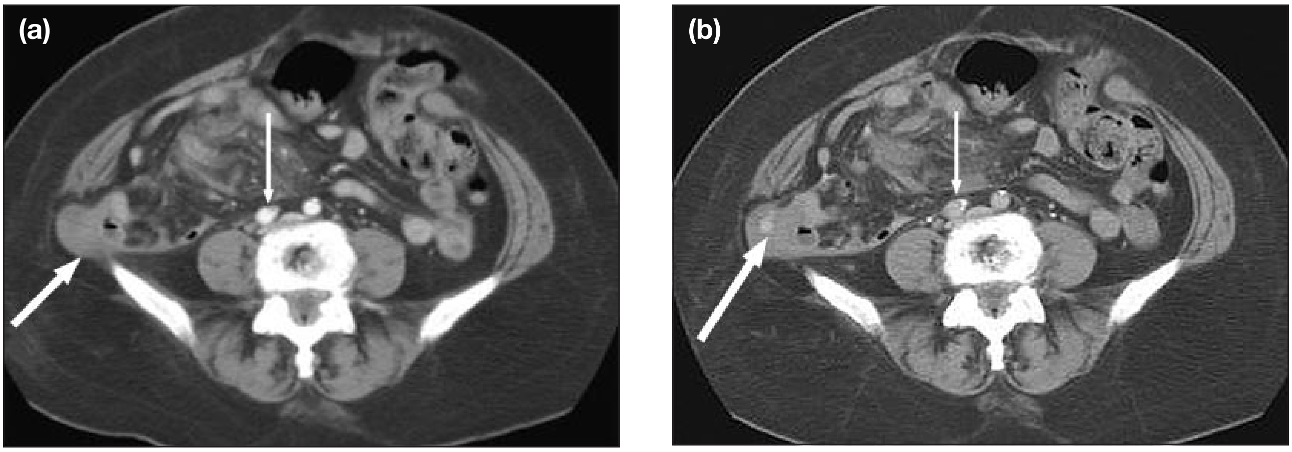

Figure 1. Venous contrast material extravasation in a post-traumatic pericolonic haematoma. (a) Arterial phase demonstrates haematoma along the right lateral aspect of the ascending colon (thick arrow) — contrast is noted in the iliac vessels indicating the arterial phase (thin arrow); and (b) delayed scan at the same level demonstrates focal contrast material extravasation within the pericolonic haematoma (thick arrow) indicating active venous haemorrhage — no contrast is seen in the iliac vessels indicating the delayed phase (thin arrow).

pseudoaneurysm, or dependent layering of contrast can also occur. The CT differentiation of a contained pseudoaneurysm from free extravasation is of particular importance since the latter indicates significant arterial bleeding requiring urgent angiographic embolisation. On delayed scans, free extravasation demonstrates continued increase in amount and density of extravasated contrast, whereas a pseudoaneurysm remains unchanged.

Although the venous system is a low-flow state, large vessel injury can lead to mortality if not recognised and treated promptly. For example, iliac vein injuries have been reported to have a 51% mortality rate. Venous CME is often demonstrated only in the late equilibrium phase and is less defined than arterial contrast extravasation (Figure 1).

Traumatic Vascular Contrast Material Extravasation

Arterial extravasation in the spleen is detected on helical CT in more than 15% of patients with splenic injury and approximately 85% of these patients will require surgery, angiographic embolisation, or both.[1] The presence of arterial extravasation, seen as a ‘contrast blush’, has recently been correlated with failure of nonsurgical management of splenic injuries in both adults and children (Figure 2). It is particularly important to differentiate between free contrast extravasation and pseudoaneurysm for splenic injury so delayed scans should be obtained for such patients.

Hepatic arterial extravasation occurs in only 10% of patients with a liver injury, but 80% of these patients will require surgical or angiographic intervention

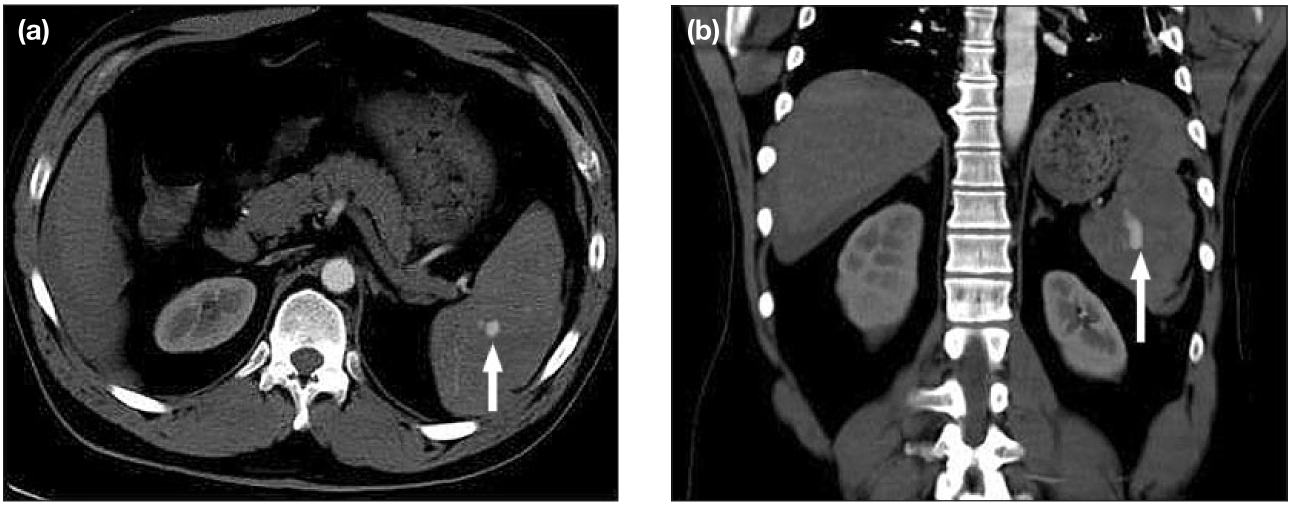

Figure 2. Splenic injury following blunt abdominal trauma. (a) Axial computed tomography scan shows focal arterial contrast material extravasation representing active haemorrhage (arrow); and (b) coronal reformat demonstrating focal arterial contrast material extravasation.

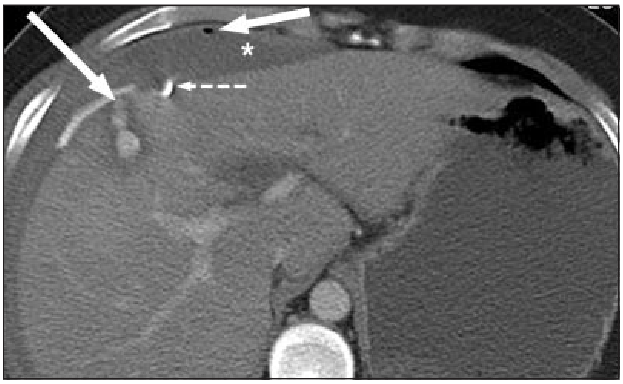

Figure 3. Liver laceration following a bullet injury. Axial computed tomography scan shows haemoperitoneum (asterisk), free intraperitoneal air (short arrow), a metallic pellet on the liver surface (dotted arrow), and contrast material extravasation (long arrow).

(Figure 3). Approximately 20% of patients with renal injuries have evidence of arterial CME and approximately 70% of them require intervention. In contrast, only 25% of patients without intrarenal arterial CME require surgery.[1]

Intra-abdominal vascular CME, in the absence of any other evidence of solid visceral injury, often indicates a mesenteric source. Twenty five percent of patients with mesenteric injuries have arterial CME (Figure 4) and most of these patients will require surgery. However, up to 50% of patients with mesenteric injuries not associated with arterial CME also require surgery. The CT detection of a mesenteric haematoma in these patients is of vital importance.[1,2]

Haemorrhage associated with pelvic fractures is deemed ‘low flow’ when the haematoma appears as a focal homogeneous density and ‘high flow’ when associated with vascular CME.[3] Following trauma, vascular CME can also be detected in the chest wall (Figure 5), in the pleural cavity (Figure 6), and in the larynx (Figure 7).

Following catheterisation of the femoral arteries for angiographic procedures, a post-procedural haematoma often forms. Ultrasound may not pick up small

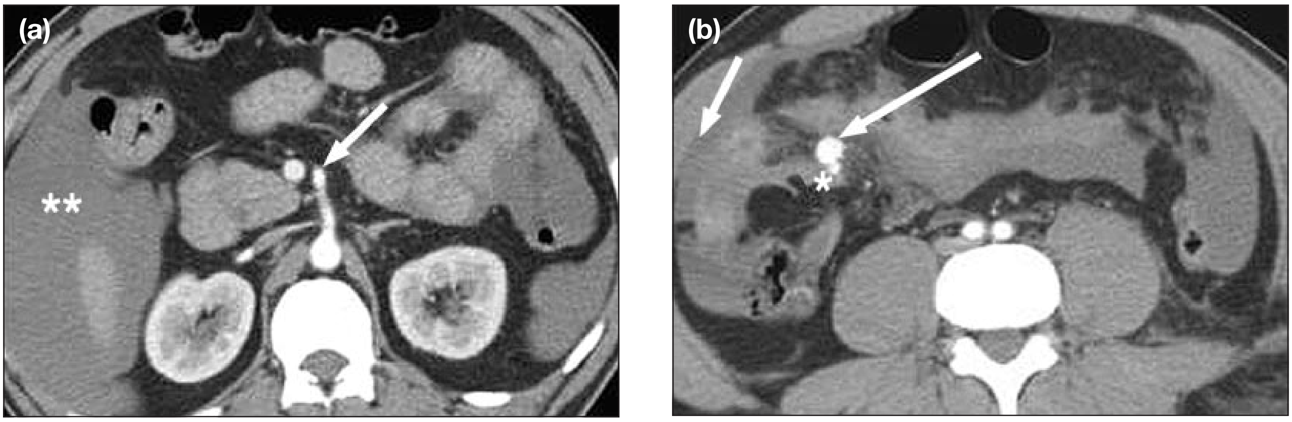

Figure 4. Blunt injury with an active mesenteric bleed. (a) Axial computed tomography scan shows a branch of superior mesenteric artery (short arrow) and haemoperitoneum (asterisks); and (b) caudal axial section demonstrates the arterial contrast material extravasation from superior mesenteric artery branch (long arrow), which is small in calibre at this level, and is seen posterior to the contrast extravasation — also seen is a mesenteric haematoma (asterisk) and haemoperitoneum (short arrow).

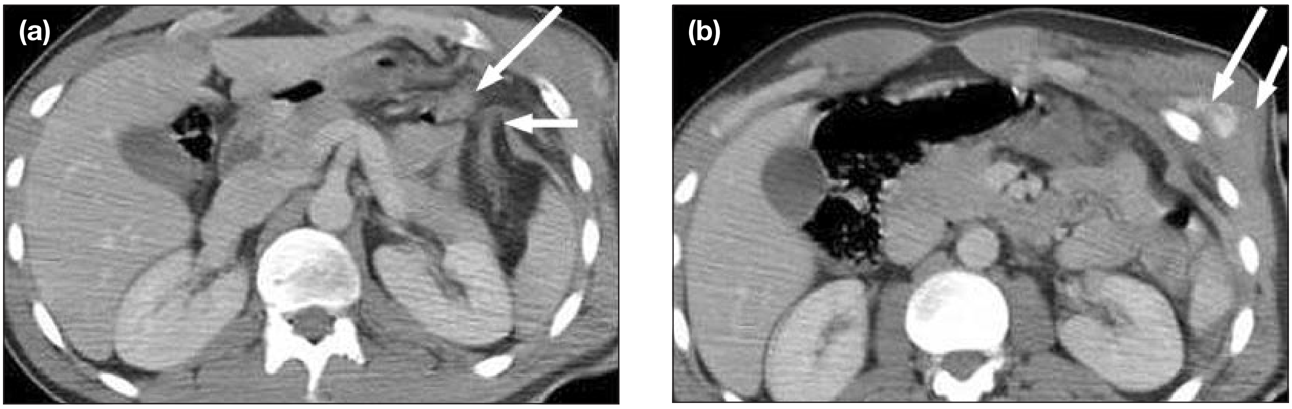

Figure 5. Left diaphragm rupture following blunt injury. Axial computed tomography scan shows (a) gastric herniation (long arrow) through a ruptured diaphragm (short arrow) — this is known as the ‘collar sign’; and (b) vascular contrast material extravasation in the chest wall (long arrow) with soft tissue haematoma (short arrow).

Figure 6. Haemothorax following trauma. Axial computed tomography scan shows a haemothorax (long arrow) and vascular contrast material extravasation (short arrow).

Figure 7. Neck trauma. Axial computed tomography scan shows a haematoma (asterisk) in the left paralaryngeal space, extending into the supraglottic larynx and effacing the left pyriform sinus. Vascular contrast material extravasation (arrow) is seen, indicating active haemorrhage.

pseudoaneurysms and does not detect active haemorrhage accurately. CT is helpful for detecting tiny pseudoaneurysms and demonstrates active haemorrhage from the site (Figure 8).

Non-traumatic Vascular Contrast Material Extravasation

On CT images, rupture of an abdominal aortic aneurysm is seen as a soft tissue hyperdensity outside an indistinct aortic wall, thinning or fracture of focal aortic calcification, haematoma penetrating into the leaves of the mesentery, and vascular CME into the adjacent psoas muscle or retroperitoneum (Figure 9). Aortic rupture is associated with a large periaortic haematoma and vascular CME may be seen at the site of a penetrating

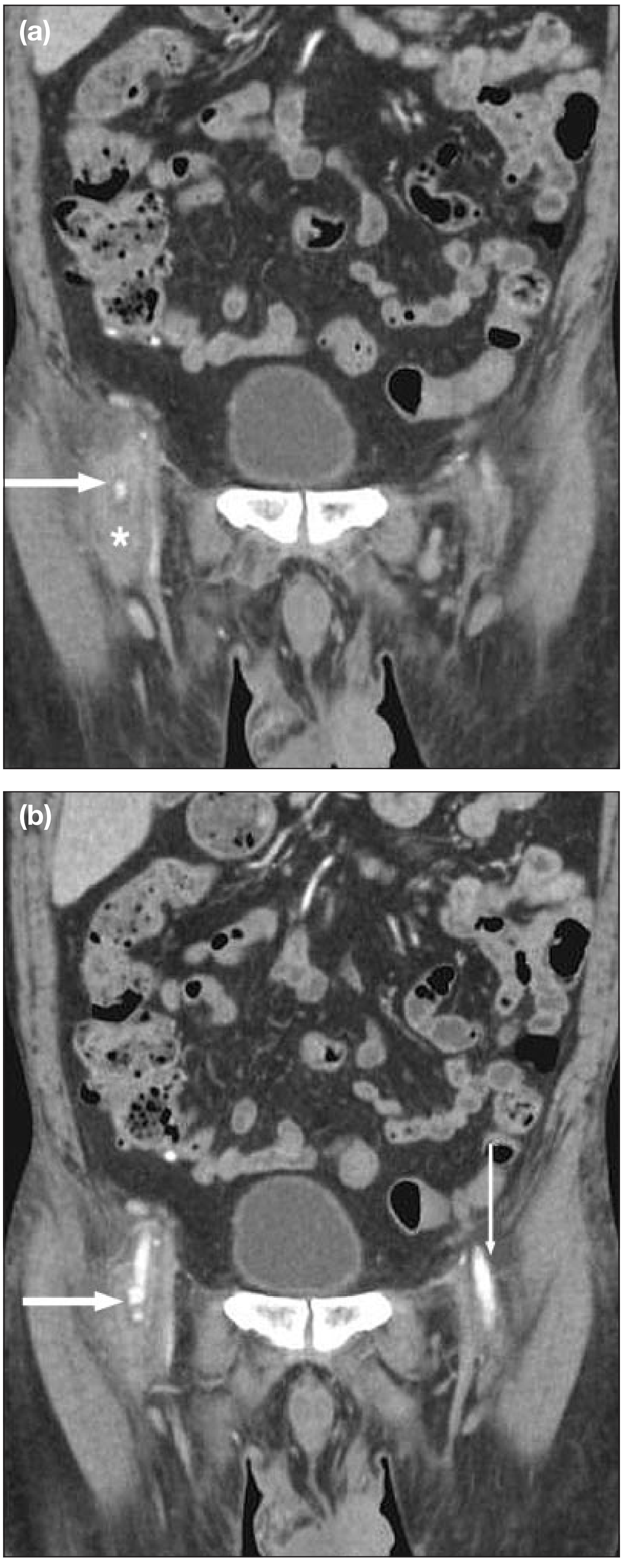

Figure 8. Iatrogenic pseudoaneurysm following femoral catheterisation. (a) Coronal reformations demonstrate a small contained contrast outpouching from the right femoral artery, which is a pseudoaneurysm (arrow) — surrounding haematoma is also seen (asterisk); and (b) coronal reformation slightly posterior to (a) demonstrates the small pseudoaneurysm (thick arrow) that arises from the anterior aspect of the right femoral artery — the left femoral artery is also seen in this section (thin arrow).

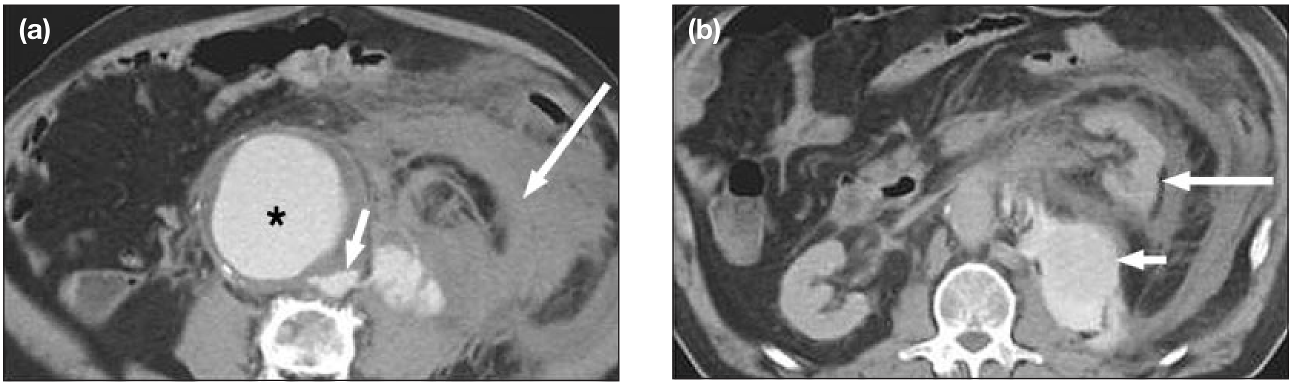

Figure 9. Ruptured aortic aneurysm causing a large retroperitoneal bleed. (a) Axial computed tomography scan shows an aortic aneurysm (asterisk) and vascular contrast material extravasation (short arrow) within a mural thrombus extending into a large left retroperitoneal haematoma (long arrow); and (b) axial computed tomography scan obtained superior to (a) shows vascular contrast material extravasation (short arrow) within a large left retroperitoneal haematoma displacing the left kidney anteriorly (large arrow).

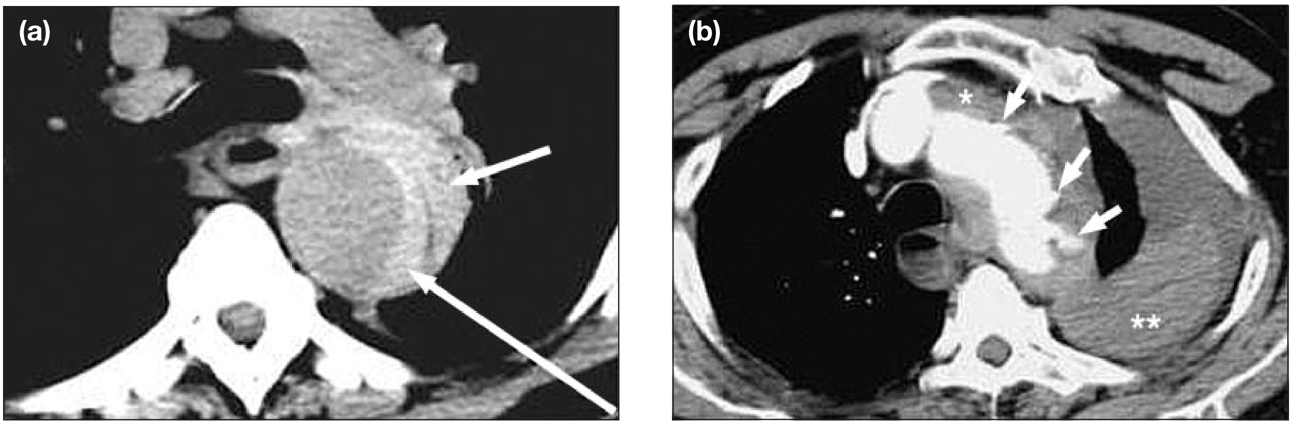

Figure 10. Spontaneous rupture of a penetrating atheromatous ulcer. (a) Axial non-contrast computed tomography obtained just below the aortic arch shows a crescentic intramural hyperdense haematoma (long arrow) and an adjacent hyperdense periaortic haematoma (short arrow); and (b) axial contrast-enhanced computed tomography obtained cranially shows multiple penetrating atheromatous ulcers (short arrows) seen as focal extensions of intraluminal contrast beyond the confines of the aortic intima. A periaortic haematoma (asterisk) and a large left haemothorax (asterisks) are also demonstrated.

atheromatous ulcer (Figure 10). An intramural haematoma appears hyperdense on non-enhanced CT and is seen as a crescent of enhancement within the aortic wall or within a mural thrombus. This ‘crescent sign’ indicates an acute or impending rupture.[3] Pseudoaneurysm is seen as an outpouching of contrast from a vessel, as seen post-catheterisation.

In a recent prospective study of 26 patients with acute massive gastrointestinal bleeding, arterial phase multidetector row CT was found to be accurate for the depiction and localisation of sites of bleeding.[4] Compared with conventional angiography and radionuclide studies, CT has the advantage of being non-invasive and has high spatial resolution, thereby identifying the exact site when CME is detected. However, CT cannot detect intermittent bleeding and is most useful for unstable patients in whom active bleeding is suspected. Radionuclide studies have the advantage of detecting slower bleeds, and are therefore useful for stable patients who have intermittent haemorrhage or a low rate of bleeding. The main disadvantage of radionuclide studies is the low spatial resolution.

Variceal bleed can be detected as vascular CME adjacent to serpentine-dilated venous channels in or around the bowel wall.

Rupture of ovarian cysts can result in a large haemoperitoneum. Vascular CME usually indicates continued haemorrhage and is an indication for intervention. Likewise, vascular CME within a tumour indicates active haemorrhage requiring intervention.

Patients receiving anticoagulants can develop large haematomas and present with decreasing haematocrit levels and hypotension. Subtle vascular CME on CT may be the only indication of active haemorrhage.

Figure 11. Trauma to the anterior abdominal wall. Axial computed tomography scan shows a large left rectus muscle haematoma (long arrow) with vascular contrast material extravasation (short arrow), indicating active haemorrhage.

Figure 12. Duodenal perforation. Axial computed tomography scan shows oral contrast within the perihepatic space (asterisk), pneumoperitoneum (asterisks), duodenal thickening (long arrow), and site of bowel contrast material extravasation (short arrow).

Spontaneous bowel and intramuscular haematomas are often seen in the setting of underlying coagulopathy.

The rectus sheath represents one of the most common sites of spontaneous musculoskeletal haemorrhage and can mimic an obstructing or incarcerated abdominal wall hernia (Figure 11). Another relatively common site of spontaneous muscular haemorrhage is the psoas muscle.

BOWEL CONTRAST MATERIAL EXTRAVASATION

Bowel CME is a sign of bowel perforation. The causes include trauma, bowel obstruction, perforated ulcer, neoplasm, or diverticulitis.

Extravasation of intraluminal contrast is the most definitive sign of bowel perforation and, when seen, depicts the exact site of the perforation (Figures 12 and 13). However, this sign is absent in many patients.

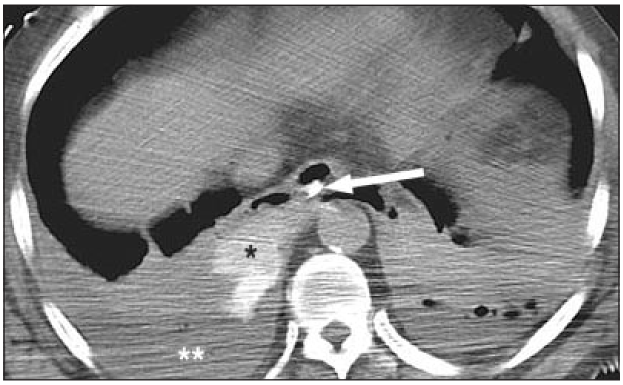

Figure 13. Oesophageal perforation. Axial computed tomography scan shows oral contrast within the right pleural space (asterisk), site of bowel contrast material extravasation (arrow), and right pleural effusion (asterisks).

Other specific CT signs of bowel perforation are bowel discontinuity, extraluminal air, and intramural air. Non-specific CT signs of bowel perforation include bowel wall thickening, bowel wall enhancement, mesenteric infiltration, and intraperitoneal or retroperitoneal fluid collections with no obvious source.[5]

Oral contrast administration given immediately prior to CT scanning does not increase the risk of clinically significant aspiration and assists in the detection of enteric perforation.[6] In the pre-helical CT era, the sensitivity of CT in the detection of bowel and mesenteric injuries was low, but now, state-of-the-art helical CT studies of bowel injury have high sensitivity and negative predictive values.[7]

URINARY CONTRAST MATERIAL EXTRAVASATION

Urinary CME is a sign of urinary leak, and is the most definitive sign of urinary injury. Urinary CME can accurately depict the site of disruption, as shown in the case of iatrogenic bladder rupture (Figure 14). The causes of urinary leak include trauma or urinary obstruction, or may be iatrogenic. Rupture of a dilated urinary system may occur spontaneously or be triggered by trivial trauma.

Specifically delayed sections are recommended for patients with suspected urinary tract trauma, as urinary leak may be completely missed on arterial or venous phase sections, leading to incorrect classification of renal trauma.[8]

CONCLUSION

This pictorial essay depicts the helical CT appearance of CME as a sign of vascular disruption in traumatic

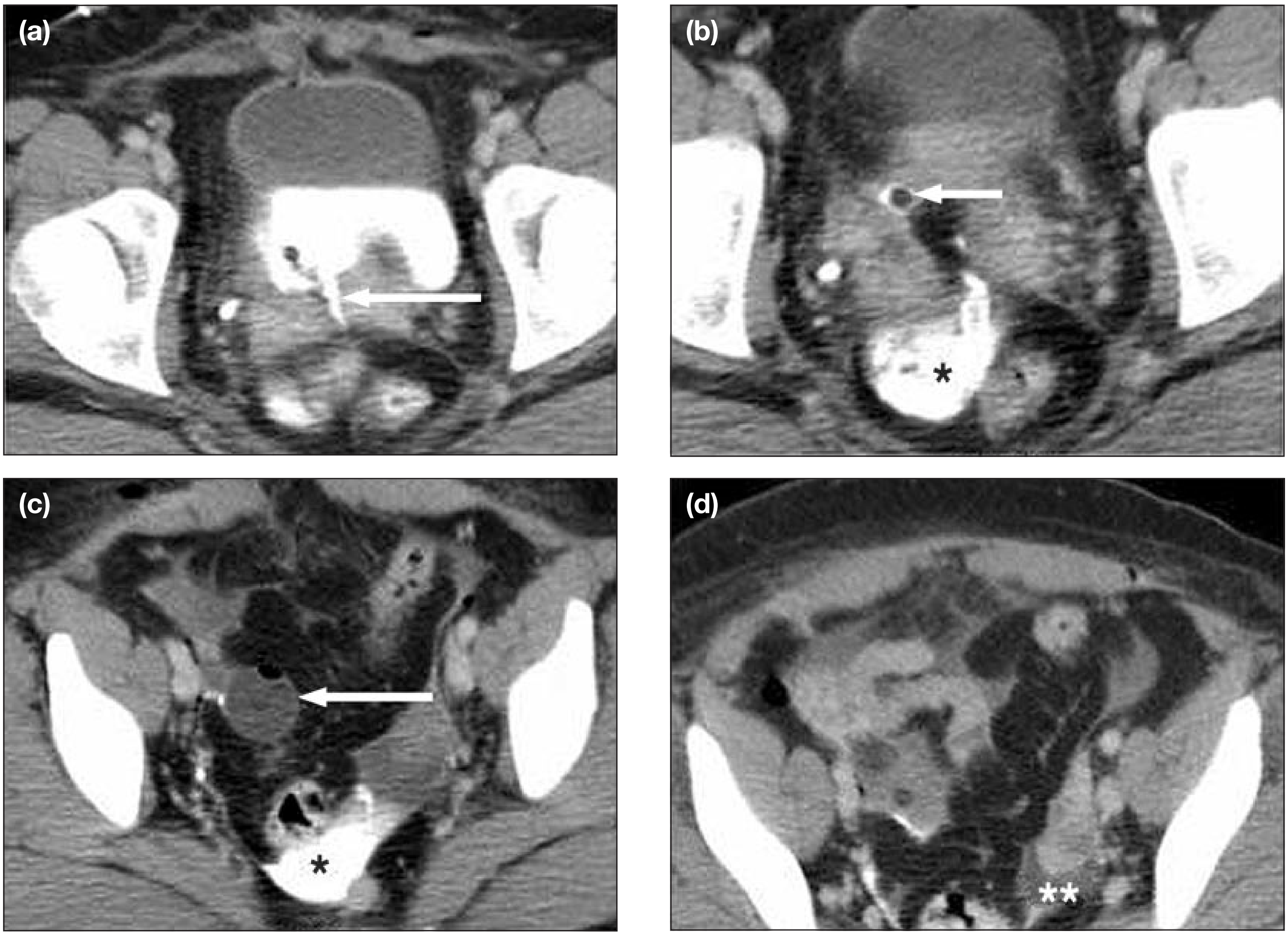

Figure 14. Iatrogenic perforation of the urinary bladder. (a) Linear contrast extravasation extending posteriorly outside the confines of the urinary bladder (arrow) indicating the site of perforation; (b) Foley's catheter tube (arrow) and a collection of extravasated contrast material in the pelvis (asterisk); (c) Foley's catheter bulb demonstrated outside the bladder (arrow) and a collection of extravasated contrast material in the pelvis (asterisk); and (d) free fluid in the pelvis (asterisks).

and non-traumatic clinical settings. Vascular disruption is a life-threatening situation that requires immediate intervention on most occasions. It is therefore essential that radiologists are familiar with the variety of appearances and their clinical significance.

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