The detection of active hemorrhage on contrast-enhanced CT as high-attenuation foci nearly isodense to adjacent vessels (Fig. 2) is usually indicative of the need for emergency embolization or surgical treatment [3].

Visceral Causes

Hepatic Causes

Spontaneous hepatic bleeding is a rare condition that is mainly due to the rupture of an underlying hypervascular tumor [4]. Rupture of a hepatic adenoma usually occurs in young women receiving long-term oral contraceptive therapy [4], whereas the highest incidence of bleeding hepatocellular carcinoma has been reported in Asian countries in cirrhotic patients with tumors located at the periphery of the liver [5]. Clinical concern for a bleeding tumor (known liver disease, decrease in hematocrit, abdominal pain) should be evaluated by unenhanced and contrast-enhanced CT to clearly identify the hematoma and the underlying hepatic lesion. On unenhanced CT images, the ruptured tumor is usually hypoattenuating, but it may be completely obscured by the adjacent subcapsular hematoma (Figs. 3A and 4A); thus, the sentinel clot sign is helpful to recognize the hepatic source of hemorrhage. The IV administration of contrast material helps to detect foci of active extravasation and to identify the ruptured hepatic tumor as a large spherical and partially exophytic enhancing mass contiguous with the subcapsular hematoma [5] (Figs. 3B and 4B). Early diagnosis by CT directs the patient to emergency treatment, such as transarterial embolization or liver resection [4, 5].

Spontaneous Abdominal Hemorrhage: Causes, CT Findings, and Clinical Implications

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Spontaneous abdominal hemorrhage is defined as the presence of intraabdominal hemorrhage from a nontraumatic and noniatrogenic cause. Common sources of spontaneous abdominal hemorrhage are visceral (hepatic, splenic, renal, and adrenal), gynecologic, coagulopathy-related, and vascular. The clinical presentation is usually nonspecific; thus, frequently the diagnosis is made on the basis of radiologic findings. Because of its speed and widespread availability, CT plays an important role in the assessment of the presence, location, and extent of hemorrhage and in the identification of the underlying cause [1–3]. This article reviews the most common causes of spontaneous abdominal hemorrhage and the CT findings that are essential for prompt diagnosis and patient management.

Appearance of Hemorrhage on CT

The appearance of hemorrhage on CT depends on its age and location. On unenhanced images, acute bleeding has an attenuation of 30–45 HU because of its high protein content. In the first few hours after hemorrhage, clotted blood appears hyperdense (HU > 60) as the concentration of hemoglobin increases, with geographic areas of high attenuation (clot) surrounded by areas of lower attenuation (serum) [1]. Clots tend to form first near the site of bleeding; thus, the identification of a heterogeneous and relatively higher attenuation clot allows localization of the site of hemorrhage (sentinel clot sign) [2] (Fig. 1). With time the clot decreases in size and density because of the progressive lysis of hemoglobin [1]. The detection of active hemorrhage on contrast-enhanced CT as high-attenuation foci nearly isodense to adjacent vessels (Fig. 2) is usually indicative of the need for emergency embolization or surgical treatment [3].

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HELLP (hemolysis, elevated liver enzymes, low platelet count) syndrome is a severe variant of preeclampsia that should always be considered in pregnant women with acute abdominal pain and accompanying laboratory abnormalities. This serious obstetric condition may be associated with hepatic necrosis and intrahepatic hemorrhagic infarction. In these patients, CT is the study of choice to detect hepatic subcapsular hematomas, intrahepatic liver hemorrhage, and infarcts (Fig. 5). Treatment consists of expeditious delivery of the neonate and emergency surgery or selective embolization of hepatic arteries in case of liver rupture for the mother [4, 6].

**Splenic Causes**

Spontaneous splenic rupture is rare and mainly occurs in cases of marked splenomegaly because of underlying hematologic malignancies (acute leukemia or lymphoma) or infectious causes such as mononucleosis or Cytomegalovirus organisms in young patients [7]. Clinical presentation includes acute abdominal and shoulder pain due to diaphragmatic irritation. Diagnosis at CT is suggested by the identification of a grossly abnormal spleen with perisplenic hemorrhage and clot in the organ (Figs. 1 and 6). Treatment may be conservative, surgical, or transcatheter embolization, depending on the grade of splenic injury and the underlying disease [7].

**Renal Causes**

Spontaneous hemorrhage into the subcapsular or perinephric space is usually the result of rupture of a renal tumor, such as angiomylipoma or renal cell carcinoma (RCC) [8]. In most cases, CT permits the radiologist to clearly differentiate a mass from the surrounding hematoma. The diagnosis of an underlying angiomylipoma is based on the identification of low-attenuation areas of fat in a large heterogeneous mass (Fig. 7). On contrast-enhanced CT, the presence of a solid mass with less contrast enhancement than the adjacent renal parenchyma suggests RCC. However, small tumors may initially be obscured by the hematoma; therefore, follow-up imaging after resolution of the initial hematoma is essential [8] (Fig. 8).

Spontaneous renal or perirenal hemorrhage may also result from coagulopathy or vasculitis, such as polyarteritis nodosa and Wegener’s granulomatosis (Fig. 9). Rarely, the accumulation of blood in the perinephric subcapsular space can compress the renal parenchyma, leading to ischemia and subsequent high renin hypertension (Page kidney) [9].

**Adrenal Causes**

Spontaneous adrenal hemorrhage is an uncommon condition that is usually bilateral and associated with anticoagulation therapy, severe stress, or sepsis. Bilateral adrenal hemorrhage may be complicated by life-threatening adrenal insufficiency. CT reveals enlarged hyperdense adrenal glands (Fig. 10A) without appreciable enhancement after the IV administration of contrast material [10] (Fig. 10B).

**Gynecologic and Obstetric Causes**

Rupture of an ectopic pregnancy or rupture of an ovarian cyst are the most common causes of spontaneous hemoperitoneum in women of childbearing age [11, 12].

Ectopic pregnancy is a potentially life-threatening condition that must be considered in every woman of reproductive age with abdominal or pelvic pain, usually starting with measuring the serum HCG and performing pelvic sonography. In the emergency setting, CT may be performed in these patients because of the presenting severe symptoms and a falsely negative urine pregnancy test. Ectopic pregnancy commonly occurs in the fallopian tube and presents as a ring-enhancing adnexal cystic mass surrounded by hemoperitoneum [11] (Fig. 11). Correct diagnosis often leads to emergency laparotomy.

Spontaneous abdominal hemorrhage associated with toxemia is usually a manifestation of the HELLP syndrome, as previously discussed.

Rupture of an ovarian cyst should be suspected in young women presenting with pelvic pain and negative serum β-HCG. When the source of bleeding cannot be localized on sonography, CT better detects the ruptured cyst as a mixed-attenuation mass in the context of a high-density pelvic hematoma [12] (Fig. 12).

**Coagulopathy-Related Spontaneous Abdominal Hemorrhage**

Abdominal hemorrhage due to anticoagulation or bleeding diatheses (e.g., hepatic failure, hemophilia, idiopathic thrombocytopenic purpura, systemic lupus erythematosus) commonly involves multiple sites, and especially the body wall muscle compartments, such as the rectus sheath or the iliopecto muscle [13]. Abdominal viscera are less commonly the sites of coagulopathic hemorrhage, but perirenal and intramural bowel hematomas are not rare. On CT, the presence of a cellular–fluid level caused by the settling of cellular elements in the dependent portion of a hematoma, the so-called hemocrotic sign, is a highly sensitive (87%) and specific sign of coagulopathic hemorrhage [14] (Fig. 13). When contrast-enhanced CT detects coagulopathy-associated active extravasation, this is more frequently venous than arterial, usually not requiring surgery or embolization. Treatment is mainly conservative and based on withholding of anticoagulant medications [14] (Fig. 14).

**Vascular Causes**

CT is usually performed in patients with known abdominal aortic aneurysm (AAA) presenting with abdominal pain to exclude rupture or to identify other causes for the patient’s symptoms [15]. On unenhanced CT images, findings associated with increased risk of rupture include increasing diameter of the aneurysm (>5 cm), focal discontinuity in circumferential wall calcifications, and presence of a crescent-shaped area of high attenuation in the mural thrombus or in the aneurysmal wall, known as the hyperattenuating crescent sign [16] (Fig. 15). An early contained rupture may manifest with the “draped aorta” sign (Fig. 16), which is considered present when the posterior wall of the aorta is not identifiable as distinct from adjacent structures [17]. Rupture is usually associated with a large retroperitoneal hematoma adjacent to the aneurysm [15] (Fig. 17). In patients with a concomitant coagulopathic condition, it is critical to determine the cause of the retroperitoneal hematoma because a ruptured AAA requires prompt treatment by surgery or endovascular intervention, whereas surgery is usually contraindicated in cases of coagulopathic hemorrhage [14, 15]. The presence of an aneurysm greater than 4 cm in diameter with hemorrhage contiguous with the aorta for a length of at least 3 cm and the absence of the “hemocrotic” sign are findings suggestive of ruptured AAA [14].

Less common vascular causes of spontaneous abdominal hemorrhage include rupture of a splanchnic artery aneurysm (mainly the splenic and hepatic arteries) [18] and erosion of a vessel by an adjacent neoplastic or inflammatory disorder (e.g., pancreatitis) [19].

**Summary**

Knowledge of the common CT manifestations of various causes of spontaneous abdominal hemorrhage allows their accurate
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Diagnosis and has a direct impact on clinical decision making.

References

Fig. 1—33-year-old man with AIDS and underlying infection with *Cytomegalovirus* organism causing spontaneous splenic rupture. A and B, Axial unenhanced (A) and contrast-enhanced (B) CT sections obtained at slightly different levels show splenic laceration (arrow, B) with hyperdense sentinel clot (ROI [region of interest] 1 = 52 HU, A) surrounding spleen, and relatively lower density lysed blood (ROI 2 = 35 HU, A) surrounding liver.
Fig. 2—55-year-old man with acute decrease in hematocrit level 1 day after colon resection for adenocarcinoma. Axial contrast-enhanced CT section shows focus of active extravasation of contrast material as serpiginous high-attenuation (140 HU) area (arrow) in large mesenteric hematoma.

Fig. 3—29-year-old woman with surgically proven ruptured hepatic adenoma. 
A, Axial unenhanced CT section shows subcapsular hematoma with higher density sentinel clot (arrow) along right posterior hepatic lobe. 
B, Axial contrast-enhanced CT section, obtained at slightly different level from A, shows spherical heterogeneously hypervascular hepatic mass (arrow), adjacent to clot, proven to be ruptured hepatic adenoma at resection.

Fig. 4—54-year-old man with acute abdominal pain and surgically proven ruptured hepatocellular carcinoma (HCC). 
A, Axial unenhanced CT section shows diffusely low-attenuation liver parenchyma and surrounding hyperattenuating perihepatic fluid (white arrows) with ill-defined subtle mass in left hepatic lobe (black arrow), suggestive of underlying mass. 
B, Axial contrast-enhanced CT section, obtained at same level as A, shows spherical heterogeneously hypervascular mass (arrow) in left hepatic lobe. Left hepatic lobectomy proved bleeding HCC associated with hemoperitoneum.
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Fig. 5—36-year-old woman with toxemia of pregnancy, right upper quadrant pain, and falling hematocrit (HELLP [hemolysis, elevated liver enzymes, low platelet count] syndrome). Axial contrast-enhanced CT section shows nonenhancing hepatic foci (white asterisk) due to infarction and hematoma, foci of active bleeding (white arrows), and subcapsular and perihepatic hemorrhage (black asterisks).

Fig. 6—43-year-old man with underlying B cell lymphoma and spontaneous splenic rupture. Axial contrast-enhanced CT section shows splenomegaly with parenchymal laceration (straight white arrow) and large eccentric mass (black arrows), proven to be tumor and hematoma, with foci of calcification (curved arrow).

Fig. 7—25-year-old man with tuberous sclerosis and acute onset of right flank pain due to spontaneous rupture of renal angiomyolipoma. Axial unenhanced CT section shows large fat-containing mass (arrow) in right kidney with extensive perirenal hemorrhage (asterisk).
Fig. 8—50-year-old man with acute left flank pain due to spontaneous bleeding from renal cell carcinoma (RCC).

A, Axial unenhanced CT section through left kidney shows perirenal hemorrhage (white arrows) and subtle renal peripheral mass (black arrow) that is nearly isodense to surrounding renal parenchyma. No IV contrast material was given because of prior anaphylactic reaction to its use.

B, Coronal unenhanced T1-weighted (TR/TE, 145/4.2) MR image shows left renal exophytic mass (black arrow) that is isointense to surrounding renal parenchyma and hyperintense adjacent hematoma (white arrows).

C, Axial unenhanced CT section, obtained 4 weeks later than A, shows partial resolution of perirenal hemorrhage and detectable renal exophytic mass (arrow). RCC was proven at partial nephrectomy.
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Fig. 9—66-year-old man with bilateral renal bleeding from Wegener’s vasculitis who presented with abdominal pain. Axial unenhanced CT section shows bilateral perirenal hematomas (*asterisks*).

Fig. 10—46-year-old woman with abdominal pain and hypotension after surgery for colon carcinoma, spontaneous adrenal hemorrhage, and insufficiency. A and B, Axial unenhanced (A) and contrast-enhanced (B) CT sections obtained at same level show hyperattenuating (68–72 HU), enlarged bilateral adrenal glands (arrows, A) with no significant enhancement (78–94 HU) (arrows, B) after injection of contrast material.
Fig. 11—42-year-old woman with increasing pelvic pain and negative urine pregnancy test. Axial contrast-enhanced CT section shows pelvic hematoma (black arrows) around ring-enhancing left adnexal mass (white arrow) and adjacent high-attenuation foci indicative of active bleeding (curved arrow). Rupture of ectopic pregnancy in left fallopian tube was confirmed at surgery. Serum β-HCG test confirmed elevated levels after completion of CT scan.

Fig. 12—23-year-old woman with sudden onset of pelvic pain due to ruptured corpus luteum with hemoperitoneum. A and B, Axial contrast-enhanced CT sections through pelvis (A) and lower abdomen (B) show corpus luteum with enhancing wall and intracystic hemorrhagic component (arrow; A) in left ovary, surrounded by pelvic hematoma (ROI [region of interest], A; mean attenuation, 77 HU; sentinel clot) and relatively lower density blood in paracolic gutters (ROIs, B; mean attenuation, 34 HU).
Fig. 13—Coagulopathic hemorrhage. 
A, 80-year-old man undergoing chronic warfarin therapy with acute onset of abdominal pain and palpable abdominal wall mass due to spontaneous coagulopathic hemorrhage. Axial unenhanced CT section shows enlargement of right rectus abdominal muscle with cellular–fluid level ("hematocrit" sign, arrow), which is diagnostic of coagulopathic rectus sheath hematoma.
B, 45-year-old woman with hemophilia and back pain due to spontaneous coagulopathic hemorrhage. Axial contrast-enhanced CT section shows multi-compartment hemorrhage including left perirenal (asterisk) and right iliopsoas with hematocrit sign (straight arrow) and active extravasation of contrast material (curved arrow).

Fig. 14—50-year-old man undergoing heparin therapy for prevention of deep venous thrombosis with spontaneous perirenal hemorrhage. 
A, Axial unenhanced CT section shows large hyperdense clot (asterisk) in right perirenal space. 
B, Axial unenhanced CT section obtained at same level as A, 14 days after heparin was withheld, shows slow resolution of hematoma (asterisk) and decrease in size and attenuation.
Fig. 15—74-year-old man with back pain and impending or early rupture of known abdominal aortic aneurysm (AAA). Axial unenhanced CT section shows large AAA with crescent-shaped area of high attenuation in mural thrombus (hyperattenuating crescent sign, arrow), which is associated with increased risk of rupture.

Fig. 16—70-year-old man with abdominal pain and hypotension due to rupture of abdominal aortic aneurysm (AAA). A and B, Axial contrast-enhanced CT sections obtained at slightly different levels show large AAA (arrow, A) with eccentric posterior bulge ("draped aorta" sign) and indistinct margins with iliopectoas compartment (arrows, B).
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Fig. 17—62-year-old woman with ruptured abdominal aortic aneurysm (AAA). 
A and B, Axial unenhanced (A) and contrast-enhanced (B) CT sections obtained at same level show AAA with large adjacent hemorrhage involving multiple right retroperitoneal compartments (asterisks, A) and periaortic extravasation (arrow, B).

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