Blood Is Everywhere!

Important Potential and Emergent Causes of Bleeding In the Abdomen and Pelvis

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Hemoperitoneum

• Many trauma and atraumatic causes
• CT remains the “work horse” of evaluation
  • Fast with multiple time-point imaging
• CT signs of hemoperitoneum:
  • “Sentinel clot”
  • Active arterial extravasation
  • Mesenteric fluid
• Blood has $\uparrow$ HU than other body fluids. However...
  • Depends on age, extent, and location
  • Unclotted extravascular blood $\approx 30–45$ HU
  • $<30$ HU if (a) ↓ serum hematocrit level, (b) anticoagulation, or (c) hemorrhage $>48$ hours old
• Locating the source of intraperitoneal hemorrhage can help direct management
Trauma

- Leading cause of death in the US < 45 years old
- Fourth highest overall cause of death
- FAST scan ultrasonography
  - Assess for hemopericardium and hemoperitoneum
  - Image the hepatorenal recess (Morison's pouch), perisplenic space, pericardium, and pelvis
- **Most common** location of bleed: liver, spleen
- Unique complication: “Page kidney”
- **Trauma grading**: American Association for the Surgery of Trauma (AAST)

Important CT findings of trauma

- **Solid organ injury**
  - Sentinel clot
  - High-attenuation fluid
    - Near or around the injured organ
    - In the cul-de-sacs, paracolic gutters, pelvis
  - Active extravasation:
    1. Active bleeding from a vessel on angiographic phase
    2. Serpiginous border of high-attenuation
    3. Changes in attenuation/morphology on multiphase imaging

- **Mesenteric or bowel injury**
  - Triangular high-attenuation interloop mesenteric fluid collections
  - Bowel wall thickening
  - Other signs of active extravasation in mesentery or by bowel loops
Case 1: Trauma

**HISTORY:** 53 yo status post motor vehicle collision, unstable vitals

**IMAGING:**
- **Post-contrast CT:** Hypoattenuating splenic lacerations (arrow) and active extravasation of contrast
- **Angiography:** Splenic artery aneurysm near the hilum and active extravasation (arrow)
- **Angiography post-embolization** with coils placed in the splenic aneurysm (orange arrow). No flow distal to the spleen and no further extravasation

**TREATMENT:** Embolization, solid organ removal, or observation depending on patient stability and available therapies
Case 2: Trauma, now hypertensive

- **HISTORY:** 32 yo s/p motor vehicle accident and with subsequent hypertension

- **IMAGING:**
  - Post-contrast CT (top): Subcapsular hyperattenuating fluid (arrow) compressing the left renal parenchyma, findings consistent with traumatic page kidney
    - Page kidney: Hypertension secondary to renal compression usually associated with a perinephric or subcapsular hematoma
  - Fluoroscopy (bottom) after drain placement with injected contrast in the subcapsular space

- **TREATMENT:** Surgical approach (nephrectomy or hematoma evacuation) and antihypertensive treatment
Vascular

- Intraperitoneal bleeding from vascular lesions is less common than retroperitoneal hemorrhage; however, morbidity and mortality can be high

- Acquired vascular lesions:
  - Aneurysms
  - Pseudoaneurysms
  - Angiodysplasia

- Congenital vascular lesions:
  - Arteriovenous malformations

- Special case: In young patients, splanchnic artery aneurysms should increase search for systemic vascular disease, most notably type IV Ehlers-Danlos syndrome. In patients with Ehlers-Danlos syndrome:
  - May present with a spontaneous aneurysm rupture
  - Angiography may be contraindicated because of the risk of aneurysm formation at the site of puncture and other vascular injury/complications
Aneurysm vs pseudoaneurysm

- **Aneurysm:**
  - Arterial dilation with intact vessel wall layers
  - Abdominal aortic aneurysm:
    - 300 million people globally
    - Elective repair common at 5.5cm
    - Without repair, ruptured is often fatal
  - Splenic artery aneurysm:
    - Most common visceral aneurysm (60%)
    - Spontaneous rupture occurs in 3%–10% of splenic artery aneurysms
    - Danger of rupture if large, in pregnant patient, or in patient with advanced liver disease

- **Pseudoaneurysm:**
  - Injury to all 3 layers of the arterial wall
  - Contained rupture with perfused sac that communicates with artery
  - Pseudoaneurysms of the hepatic, splenic, and gastroduodenal arteries can be complications of pancreatitis
  - Risk factors for major vascular complications of pancreatitis include: necrotizing pancreatitis, multi-organ failure, sepsis, and pancreatic fluid-collections such as abscesses, pseudocysts or walled-off necrosis
Case 3: Abdominal pain and syncope

- **HISTORY:** 93 yo male presenting with progressive abdominal pain for 24 hours
- **IMAGING:**
  - Pre-contrast CT with free abdominal fluid measuring 38 HU.
  - Arterial phase (axial and sagittal) CT: Enlarged abdominal aorta with active extravasation of contrast (arrows) and significant periaortic fat stranding/hemorrhage indicating an abdominal aortic aneurysm rupture.
  - Sagittal CT: Aortic wall defect (orange arrow)
  - Delayed images demonstrating extravasated contrast spreading throughout the peritoneal cavity
  - Patient died within 1 hour of CT
- **TREATMENT:** Stabilize patient and emergent surgical or endovascular aortic repair
Case 4: Recent pancreatitis

**HISTORY:** 58 yo M with episode of acute pancreatitis, now with new onset upper abdominal pain

**IMAGING:**
- Post-contrast CT axial and coronal images with a splenic artery pseudoaneurysm (arrowhead) within a pancreatic pseudocyst (arrow) and surrounding fat stranding
- Angiography demonstrating the splenic artery pseudoaneurysm (arrowhead) with active extravasation (arrow)

**TREATMENT:** Stabilization if bleeding actively. Embolization due to current bleeding or to prevent future bleeding because of the high risk
Gastrointestinal bleed

• Though not typically a cause of hemoperitoneum, gastrointestinal (GI) bleeds can be life threatening

• GI bleed
  • Can occur anywhere along the GI tract and pass through the bowel
  • Etiologies: mass, angiodysplasia, inflammation

• CTA remains an important diagnostic tool for nonvariceal upper GI bleeds but is less useful in lower GI bleeds

• ACR Appropriateness Criteria for lower GI bleeds state CTA use is usually appropriate as the next procedure/intervention for:
  • Active bleeding with hematochezia or melena in a hemodynamically stable patient
  • Intermittent or obscure non-localized recurrent bleeding

• CTA use may be appropriate when:
  • Active bleeding in a hemodynamically unstable patient or a patient who has required more than 5 units of blood
  • However, transcatheter arteriography/intervention (TAI) is usually recommended in this circumstance

• CTA is usually NOT recommended after lower GI bleeding source is already identified
Case 5: Melena

- **HISTORY:** 71 yo with melena
- **IMAGING:**
  - Axial and coronal CTA images demonstrating active extravasation into the ascending colon near the hepatic flexure (arrows), consistent with a lower GI bleed
  - Angiography images from a selective injection demonstrating brisk passage of contrast (arrows) into the colonic lumen
- **TREATMENT:** Stabilization of the patient. Endoscopic treatment or endovascular embolization. If unavailable, open surgery may be necessary
Gynecologic

• Reproductive tract is the most common source of spontaneous hemoperitoneum in women of childbearing age

• Primary imaging modality used is US;
  • CT used if the clinical findings are nonspecific

• **Most common:** ectopic pregnancy and ruptured ovarian cyst

• **Less common:** endometriosis, uterine rupture, and HELLP syndrome (subcapsular hematoma or hepatic rupture)
Case 6: Abdominal pain, vaginal bleeding

• HISTORY: 31 yo presenting with acute onset abdominal pain

• IMAGING:
  • Post-contrast CT: Attenuating blood products ranging from 35-50 HU in the pelvis, consistent with hemoperitoneum
  • Peripherally enhancing cystic mass in the right adnexa, consistent with a hemorrhagic cyst (arrow)
  • Transvaginal ultrasound 2 days later: Small amount of residual fluid. Patient symptoms resolved by this time.

• TREATMENT: If stable, observation. In unstable patients, blood transfusion or surgical intervention may be required
Case 7: Positive β-HCG, abdominal pain

- **HISTORY:** 36 yo with a positive β-HCG and acute onset left lower quadrant abdominal pain

- **IMAGING:**
  - Transvaginal US: Thickened endometrial lining (arrowheads) with no intrauterine gestational sac
  - M-mode transvaginal US: Left adnexa with detectable fetal heart rate, consistent with a live ectopic pregnancy (arrow)

- **TREATMENT:** Emergent surgical intervention
Ectopic pregnancy

• 1% of pregnancies
  • 97% of occurrences located in either the ampullary (most common) or the isthmic portion of the fallopian tube

• Risk factors:
  • Previous ectopic pregnancy
  • Pelvic inflammatory disease
  • In vitro fertilization
  • Intrauterine device
  • Tubal surgery

• Signs of ectopic pregnancy:
  • Positive human chorionic gonadotropin level of more than 2000 IU/L and no intrauterine pregnancy
  • Extraovarian mass
Case 8: Pregnant patient with RUQ pain

• **HISTORY:** 30 yo pregnant female presenting with severe right upper quadrant pain, hypertension, and elevated liver enzymes. Emergency c-section was performed followed by CT

• **IMAGING:**
  • Non-contrast CT: Large high density subcapsular hematoma (arrow) with adjacent hepatic edema. Dependent higher density fluid corresponding to blood in the paracolic gutter (arrowhead)

• **HELLP syndrome**
  • Peripartum triad: hemolysis, elevated liver enzymes, and low platelet count
  • Disseminated intravascular coagulation in 20%-40% of patients
  • Other complications: hepatic infarction, hematoma, hepatic rupture, and placental abruption

• **TREATMENT:** Stabilize patient and delivery of the pregnancy
Iatrogenic bleeds

• Any surgical procedure may cause hemoperitoneum

• Even minimally invasive percutaneous or endovascular procedures occasionally lead to intraperitoneal hemorrhage

• Causes:
  • Direct vascular injury
    • Examples: endovascular injury, percutaneous or open surgical injury (eg. inferior epigastric artery during paracentesis)
  • Biopsy or surgery involving a solid organ or mass
    • Examples: liver, spleen, renal cell carcinoma, hepatocellular carcinoma
Case 9: Percutaneous liver biopsy

- **HISTORY:** 45 yo with severe right upper quadrant pain s/p percutaneous liver biopsy

- **IMAGING:**
  - Post-contrast axial CT:
    - Hemoperitoneum and active extravasation (arrows) from the liver biopsy site consistent with biopsy-related hemorrhage

- **TREATMENT:** Conservative management with stabilization. Consider reversing anticoagulation. Endovascular embolization if patient demonstrates hemodynamic instability or continued hemorrhage
Case 10: Severe RUQ pain after TACE

- **HISTORY:** 64 yo with abdominal pain after TACE via right femoral artery access
- **IMAGING:**
  - Post-contrast CT: No active extravasation. Higher density fluid within the right abdomen concerning for hemoperitoneum
  - Metallic closure device (arrowhead) superficial to the expected location of the femoral artery with interposed hematoma
  - Angiography showing access site. Hemorrhage from a combination of high femoral access and failed closure device
- **TREATMENT:** Monitor for stability, if active hemorrhage then may require endovascular stenting or open repair
Spontaneous bleeds

• “Spontaneous bleeds” are largely a misnomer
  • Usually anticoagulation related, with risk of bleeding proportional to the degree of anticoagulation
  • Anticoagulation most commonly causes hemorrhage into the retroperitoneum/psoas or rectus muscles, but occasionally results in hemoperitoneum

• Truly spontaneous hemoperitoneum is rare
  • Must exclude rupture of occult neoplasm

Patient with portal vein thrombosis (arrowhead) treated with TIPS/declot and anticoagulation who presents with sudden RUQ pain, no reported trauma. Large hematoma (arrow) with rupture into the perihepatic space.
Case 11: Pain and right abdominal bruising

**HISTORY:** 61 yo with chronic abdominal pain and diarrhea on low-molecular weight heparin for atrial fibrillation. Acute onset abdominal pain and hypotension

**IMAGING:**
- Post-contrast CT: **Right rectus hematoma** extending into the anterior pelvis (top left) and a second intrapelvic collection with layering dependent high density (bottom left)
- Angiography demonstrating active extraperitoneal hemorrhage (orange arrows)

**TREATMENT:** Conservative management with stabilization. Consider reversing anticoagulation. Angiography can be utilized for diagnostic and therapeutic purposes
Bleeding masses

• Spontaneous hemoperitoneum in the absence of trauma, instrumentation, or anticoagulation therapy is rare

• In such cases, a ruptured neoplasm must be excluded
  • Either primary or metastatic tumor can rupture and bleed into the peritoneal cavity but highly vascular masses more commonly bleed

• Primary masses:
  • Most common primary lesions to cause hemoperitoneum are liver and renal
  • Rupturing splenic masses are more rare than hepatic or renal
    • Etiologies: Hemangiomatosis, angiosarcoma, leukemia, or lymphoma

• Metastatic masses:
  • Spontaneous rupture is rare but can cause massive hemoperitoneum
  • Most common: Lung carcinoma, renal cell carcinoma, and melanoma
Renal masses

• Most common spontaneously hemorrhaging mass is a benign or malignant neoplasm (61%)
  • Most common: Angiomyolipoma (29%)
  • Second most common: Renal cell carcinoma (26%)

• Angiomyolipoma
  • Associated with tuberous sclerosis
  • <4cm: usually watch
  • ≥4cm: prophylactic embolization due to risk of hemorrhage
Case 12: Flank pain

• **HISTORY**: 61 yo with acute onset left flank pain

• **IMAGING**:
  - Post-contrast CT: Fat containing lesion in the inferior left kidney (arrow)
  - Surrounding hemorrhage in the perinephric space and layering in the left paracolic gutter (orange arrows), consistent with a ruptured angiomyolipoma (AML)

• **TREATMENT**: Stabilization of the patient. Endovascular embolization or resection is also a possibility, either emergently or if the lesion is ≥4cm
Hepatic masses

- Hepatocellular carcinoma (HCC)
  - Most common cause of atraumatic hemoperitoneum in male patients of all ages;
  - Nearly 15% incidence of rupture*
  - Large or peripherally located tumors without normal overlying tissue are at a higher risk for rupture

- Hepatic adenoma
  - Benign liver tumor associated with increased estrogen
  - More common in females and those on oral contraceptives
  - Avidly enhance and can contain fat

- Cavernous hemangioma
  - Few cases of hemorrhage and spontaneous rupture and hemorrhage of these lesions reported
  - Giant hemangiomas > 10 cm more likely to rupture, particularly with trauma or during pregnancy

Case 13: Acute RUQ pain

- **HISTORY:** 55 yo with hepatitis C and cirrhosis. Acute right upper quadrant abdominal pain

- **IMAGING:**
  - Post-contrast CT: Enhancing exophytic hepatic mass (arrow) with focal rupture of the overlying capsule, and surrounding perihepatic hemorrhage, consistent with ruptured hepatocellular carcinoma

- **TREATMENT:** Stabilization of the patient and observation. Endovascular embolization or hepatic resection if unstable. Treatment of the HCC after resolution of acute condition
Case 14: Acute RUQ pain

• **HISTORY:** 31 yo on oral contraceptives with acute right upper quadrant abdominal pain

• **IMAGING:**
  - Post-contrast CT: Enhancing hepatic mass (arrows) with capsule rupture (orange arrow) and surrounding perihepatic hemorrhage, consistent with ruptured hepatic adenoma and hemoperitoneum
  - In- and out-of-phase MRI: Multiple additional lesions with signal dropout, consistent with smaller, fat containing hepatic adenomas

• **TREATMENT:** Initial stabilization of the patient. Endovascular embolization or hepatic resection to stop active bleeding. Definitive treatment is hepatic resection due to high risk of future bleeding.
Conclusions

- Abdominal and pelvic hemorrhage are important causes of morbidity and mortality in the setting of both traumatic and atraumatic cases.

- The radiologist should be able to convey emergent findings and recommend appropriate additional imaging.

- Accurate identification of abdominal and pelvic hemorrhage and concise description of associated injury can help guide patient care.
References


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