The Role of Imaging in Abdominal Pain

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Choosing Wisely® Campaign

- ABIM Foundation initiative
- Designed to be “focused on encouraging physicians, patients and other health care stakeholders to think and talk about medical tests and procedures that may be unnecessary, and in some instances can cause harm.”
- Five Evidence-based recommendations from each of nine subspecialty societies
- 26 of the 45 recommendations involve appropriate use of imaging
- choosingwisely.org/
American College of Radiology Appropriateness Criteria®

- “evidence-based guidelines to assist referring physicians and other providers in making the most appropriate imaging or treatment decision for a specific clinical condition.”
Summary

- Appendicitis
- Cholelithiasis
- Diverticulitis
- Renal Calculi
- Pancreatitis
- Bowel Obstruction
- Aneurysm
- Miscellaneous
What does radiology offer for evaluation of abdomen pain?

- Acute Abdomen Series/KUB/L-spine
- Excretory Urogram/IVP/IVU
- Contrast Enema
- Ultrasound
- CT
- MRI
- Nuclear Medicine
Acute Appendicitis

- 250,000 cases per year
- Surgery is the treatment of choice
- Significant morbidity & mortality associated with surgery
- Decreased time to surgery should equate to a decrease in complications such as perforation
Appendicitis

- Etiology: Obstruction of the appendiceal lumen (lymphoid hyperplasia, fecalith, foreign body)
- RLQ pain (70%)
- Fever, N/V (40-50%)
- Leukocytosis (88%)
- False positive 20%
- False negative 20%
Appendicitis

- Conventional Radiographs
- Contrast Enema
- US
- CT
- MRI
ACR Choosing Wisely®
Recommendation

- “Don’t do computed tomography (CT) for the evaluation of suspected appendicitis in children until after ultrasound has been considered as an option. “
- “Although CT is accurate in the evaluation of suspected appendicitis in the pediatric population, ultrasound is nearly as good in experienced hands. Since ultrasound will reduce radiation exposure, ultrasound is the preferred initial consideration for imaging examination in children. If the results of the ultrasound exam are equivocal, it may be followed by CT. This approach is cost-effective, reduces potential radiation risks and has excellent accuracy, with reported sensitivity and specificity of 94 percent. “
Appendicitis

- KUB: Abnormal in <50%; Appendicolith 10-15%; Cecal ileus; SBO
- Appendicolith: When associated with abdominal pain has 90% probability of acute appendicitis and high probability of perforation
- BE: Failure to fill appendix (50-84% accuracy)
Appendicolith/Fecalith
Appendicolith/Fecalith
Appendicitis US

- Noncompressible blind ending tubular structure >6 (or 7) mm in RLQ attached to cecum
- Appendicolith 6%
- Fluid collections
- Technical limitations (bowel gas, obesity, graded compression technique, operator skill and experience)
Ultrasound for Acute Appendicitis

- The accuracy of US is reported to be between 71% & 94% for diagnosis or exclusion of appendicitis
- Advantages: No ionizing radiation, portable, no contrast material
- Disadvantages: Operator dependent, limited evaluation of other structures, limited in obese patients
- Normal appendix seen in only 10-56%
Appendix Ultrasound
Appendix Ultrasound
Appendix US
Computed Tomography for Acute Appendicitis

- CT is reported in the literature to be 93% to 98% accurate
- Less operator dependent
- Able to visualize other areas of the abdomen and pelvis for alternative abnormalities
- Techniques vary: with or without contrast
  - oral, rectal, intravenous or none
Appendicitis CT

- Enlarged appendix (>8 mm)
- Circumferentially thickened enhancing wall
- Appendicolith 25%
- Periappendicular inflammation
- Focal cecal apical thickening
- Perforation/abscess
- Limitations: Lack of intraabdominal fat
Normal Appendix CT
Acute Appendicitis
Appendicitis CT
Acute Appendicitis with Extragluminal Air
Appendicitis with Appendicololith and Abscess
Appendix MR

- Primarily used for evaluation of pregnant patients
- Contraindications and relative contraindications for MRI
- Limited availability or access of MRI
- US should be attempted prior to MR
- CT relative contraindication during pregnancy
Appendicitis MR
Cholelithiasis

- Conventional Radiographs
- US
- CT
Cholelithiasis - Radiographs

- 16% sensitive
- Lucent stones: 84%; vast majority are cholesterol stones
- Calcified stones: 16%, 2/3 of these are pigment stones
- Calcification may be lamellated or central depending on composition
- May be faceted
Cholelithiasis KUB
Cholelithiasis Ultrasound

- Up to 98% sensitive
- Mobile echogenic focus in GB lumen with posterior acoustic shadowing
- False positives from contracted GB with adjacent bowel gas (fasting study decreases this possibility), porcelain GB
- False negatives from contracted GB, obese pts, tiny stones or stone at GB neck
Cholelithiasis
Cholelithiasis Ultrasound
Gallbladder Wall Thickening
Cholelithiasis CT

- 80% sensitive: 60% of gallstones are calcified by CT
- Cholesterol stones are lower density but still often radiopaque (typically <140 HU)
- But 20% of gallstones are isodense to bile and thus undetectable by CT
- CT is not a primary modality for gallstones but often detects them incidentally in patients scanned for other reasons (pancreatitis, urolithiasis, SBO, etc.)
Cholelithiasis CT
Cholelithiasis
Porcelain Gallbladder KUB
Porcelain Gallbladder US
Porcelain Gallbladder CT
Diverticulitis

- Diverticulosis affects 5-10% in 5\textsuperscript{th} decade but 50% in 7\textsuperscript{th} decade
- 10-35% of these will have diverticulitis (about 5% of the population)
- Etiology: obstruction/perforation of diverticulum with localized pericolic abscess
- 80\% sigmoid colon
Diverticulitis

• LLQ pain / mass
• Fever (25%)
• Leukocytosis (36%)
• Acute diverticulitis often does not need any imaging if typical in presentation with no suspected complications or a history of uncomplicated diverticulitis
Diverticulitis

- Conventional Radiographs
- Contrast Enema
- CT
Diverticulitis CT
Diverticulitis
Diverticulitis with Abscess
Urolithiasis

- Conventional Radiographs
- Excretory Urogram/IVU/IVP
- US
- CT
- MRI
Urolithiasis – Conventional Radiographs/IVU

- Most (90%) are radiopaque due to calcium content
- Mildly radiopaque stones: Cystine
- Non radiopaque: Uric acid, Matrix (mucoprotein), xanthine, struvite (rarely)
- IVU for renal colic: Delayed excretion, persistent nephrogram, hydrenephrosis, columnning of contrast in ureter to point of obstruction
Staghorn Calculus
Urolithiasis - IVU
Urolithiasis - Ultrasound

- Unilateral pelvicaliectasis: up to 35% false negative
- Visualization of stone in ureter difficult between UPJ and UVJ
- Absent ureteral jet on affected side (but jet may still be present if stone is only partially obstructing)
Urolithiasis - US
Urolithiasis US
CT for Renal Calculus

- Acute renal colic evaluation
- Superior to KUB/IVU/US for detection of stones and complications
- Almost all calculi compositions are detectable by CT whereas uric acid and several other calculi are radiolucent by conventional radiographs
- CT faster and generally requires no IV contrast or enteric contrast
CT for Urolithiasis

- Signs: stone in ureter, ureteric rim sign of ST edema surrounding stone in ureter
- False +: Phlebolith (no ST rim)
- Low dose of IV contrast sometimes needed to distinguish phleboliths from ureteral calcifications
Renal Calculus CT
Renal Calculus CT
Renal Calculus CT
Urolithiasis/Hydronephrosis MRI

- Relies on T2 weighted sequences where fluid is very bright.
- Useful for problem solving for CT and US.
- Useful in pregnant patients and renal insufficiency. No gadolinium contrast agent.
- Not helpful for detecting small stones but helps distinguish physiologic hydronephrosis from other causes such as a stone or mass causing the obstruction.
Figure 6b. Comparison of different sequences used for excretory MR urography.

MR Urography

Figure 14a. High-grade inflammatory stricture in a 68-year-old man with hydronephrosis.
Figure 9a. Physiologic hydronephrosis in a 28-year-old woman late in the 2nd trimester of pregnancy.

Figure 9b. Physiologic hydronephrosis in a 28-year-old woman late in the 2nd trimester of pregnancy.
Pancreatitis

- Conventional Radiographs
- US
- CT
Pancreatitis

- Idiopathic
- Alcoholic (70% chronic)
- Cholelithiasis
- Metabolic (Hypercalcemia)
- Trauma
- Drugs
- Structural (pancreas divisum)
- Neoplasm
Acute Pancreatitis

- Abdominal pain radiating to back in 50%
- Nausea/vomiting
- Elevated amylase/lipase
- Ranson’s criteria: Mortality 15-20% if meet 3 or 4 criteria
- CT classification
Ranson's Criteria for Pancreatitis Mortality
Evaluate on admission and at 48 hours after admission.

On Admission:
• Age > 55?  
  Yes +1
• WBC > 16 on admission?  
  Yes +1
• Glucose > 200 (US) > 10 (SI) on admission?  
  Yes +1
• LDH > 350 on admission?  
  Yes +1
• AST > 250 on admission?  
  Yes +1

At 48 hours After Admission:
• Hct drop > 10% within 48h of admission?  
  Yes +1
• BUN increase > 5 US (> 1.79 SI) within 48h of admission?  
  Yes +1
• Ca < 8 (US) < 2 (SI) within 48h of admission?  
  Yes +1
• Arterial pO2 < 60 within 48h of admission?  
  Yes +1
• Base deficit (24 - HCO₃⁻) > 4 within 48h of admission?  
  Yes +1
• Fluid needs > 6L within 48h of admission?  
  Yes +1

Score
Acute Pancreatitis

- CT findings and prognosis
- Rule of 1/3’s: 1/3 normal, 1/3 focal, 1/3 diffuse
- Edematous pancreatitis = Mild or no edematous changes and has good prognosis, 4% mortality
- Necrotizing pancreatitis = Lack of enhancement of pancreatic parenchyma, very high morbidity and mortality
- Hemorrhagic or suppurative types also have high morbidity and mortality
Chronic Pancreatitis - KUB
Normal Pancreas
Edematous Pancreatitis
Necrotizing Pancreatitis
Necrotizing Pancreatitis
Pancreatitis with Pseudocyst
Bowel Obstruction

- Adhesion
- Hernia
- Volvulus
- Intussusception
- Tumor
- Stone/Bezoar/Foreign Body
Bowel Obstruction

- Conventional Radiographs
- Small Bowel Exam (SBFT/Enteroclysis)
- CT
Bowel Obstruction - Radiographs
Free Intraperitoneal Air
Double Bowel Wall Sign
Free Intraperitoneal Air
Bowel Obstruction - Hernia
Bowel Obstruction - CT

- Transition zone from dilated to normal caliber bowel
- Follow course of bowel on serial images
Bowel Obstruction – CT
Hernia
Bowel Obstruction – CT
Internal Hernia
Bowel Obstruction - CT
Gallstone Ileus
Bowel Obstruction
Colon Cancer
Abdominal Aortic Aneurysm

- Focal widening >3 cm
- 6% of population >80 y.o.
- Risk factors: M>F, age, HTN, smoking, FH
- Asymptomatic (30%), Mass (26%), abdominal pain (37%)
- Rupture: <4 cm is about 10%, 5-7 cm is 25%, 7-10 cm is about 50%
- Rupture: 64-94% die before they reach ED
Abdominal Aortic Aneurysm

- Conventional Radiographs: 75-85% show mural calcification
- US: 98% accuracy for size
- NCCT: Crescent sign of increased peripheral area in aneurysm wall = impending rupture
- CECT: Displaced structures, hematoma, “cobwebs”, extravasation of contrast
Aneurysm
Aneurysm - US
Aneurysm
Miscellaneous

- Ischemia
- Infection: pyelonephritis, abscess, C. difficile colitis
- IBD: Crohn/UC
- Lymphoma
- Hematoma: Anticoagulation, Iatrogenic
Ischemia
Pyelonephritis
Crohn Disease
Epiploic Appendagitis
Got Stomach Pain?

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- American Gastroenterological Association includes the following recommendation:

  “For a patient with functional abdominal pain syndrome (as per ROME III criteria) computed tomography (CT) scans should not be repeated unless there is a major change in clinical findings or symptoms. “

  “There is a small, but measurable increase in one’s cancer risk from x-ray exposure. An abdominal CT scan is one of the higher radiation exposure x-rays — equivalent to three years of natural background radiation. Due to this risk and the high costs of this procedure, CT scans should be performed only when they are likely to provide useful information that changes patient management. “
D. Functional Abdominal Pain Syndrome

*Diagnostic criteria* Must include all of the following:

- Continuous or nearly continuous abdominal pain
- No or only occasional relationship of pain with physiological events (e.g., eating, defecation, or menses)
- Some loss of daily functioning
- The pain is not feigned (e.g., malingering)
- Insufficient symptoms to meet criteria for another functional gastrointestinal disorder that would explain the pain

*Criteria fulfilled for the last 3 months with symptom onset at least 6 months prior to diagnosis*

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