Imaging of Abdominal Pain: Plan Before You Scan

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Disclosures
• None

Objectives
• Understand the capabilities and limitations of imaging modalities used in evaluating abdominal pain.
• Synthesize clinical presentation and available data to choose the best imaging modality.
• Develop confidence in acting on significant findings and taking the "next" step.
• Review special clinical scenarios that may alter how you evaluate abdominal pain.
The Players

- Ultrasound
- Computed Tomography
- Magnetic Resonance Imaging
- Other: Nuclear Medicine

Conventional Radiograph

**Pros**
- Widely available
- Timely
- Low radiation dose (1/20th compared to CT)

**Cons**
- Nonspecific
- Additional imaging often needed

Tip: Unless you have a very specific question, skip the radiograph

Ultrasound

**Pros**
- Accessible in most clinical settings
- Dynamic exam
- Good solid organ and fluid evaluation
- No radiation

**Cons**
- Operator-dependent
- Patient-dependent
- Limited viscous evaluation
CT

**Pros**
- Widely available
- Rapid throughput
- Most complete anatomic evaluation
- High accuracy

**Cons**
- Ionizing radiation
- Some limits with renal impairment, pregnancy, etc.

Tip: Most common first line imaging for abdominal pain

CT – The Data

- Appendicitis – PPV – 95%
- Clinical diagnosis
  - Before CT – 71%
  - After CT – 93%
  - Change in management – 46%

MRI

**Pros**
- Great tissue contrast
- Less need for contrast
- No radiation

**Cons**
- Not readily accessible
- Patient limitations
  - Size
  - Claustrophobia
  - Metal/medical devices
Nuclear Medicine
- Combination of anatomic and functional information
- Gallbladder scintigraphy
- GI bleed
- Not first line
- Answers very specific questions

Clinical Approach
- What a radiologist hopes for
  - Detailed history
  - PMH
  - Physical exam
  - Pertinent labs
- What a radiologist gets:
  - r/o pathology
Ordering the Imaging

- Let the symptoms and physical exam guide the imaging
- RUQ pain – US most common first exam
- Other quadrants – CT is primary modality
- Contrast
  - Iodinated contrast improves sensitivity
  - Be aware of allergies and renal function
  - Without/With is very 1993 – Not necessary
  - Oral contrast – Not necessary, slows throughput
Appropriateness Criteria (ACR)

Plain Radiograph
- In general, SKIP IT
- Specific Questions
  - Kidney Stones
  - Free Air
  - Stool 'Quantification'

Common Diagnoses
- RUQ – Acute cholecystitis
- RLQ – Acute Appendicitis
- LLQ – Acute Diverticulitis
- Diffuse – Small bowel obstruction
Acute Cholecystitis

- Highly associated with cholelithiasis
- 120K cholecystectomies
- RUQ pain/tenderness, fever, leukocytosis
- US – 88% Sensitivity, 80% Specificity
- US features
  - Stones
  - Wall thickening (>4mm)
  - Pericholecystic fluid
  - Positive Sonographic Murphy’s

Positive/suspicious report? Next step?
- Surgical consultation
  - Institution dependent
  - May take to surgery
  - May request more imaging (HIDA, MRCP)
  - Cholecystostomy tube
- Equivocal findings? Cholelithiasis?
  - Conservative management
  - Non-urgent surgical consult

Acute Appendicitis

- 14% of ED patients with abdominal pain
- Early – generalized pain, Late – localized RLQ
- Historically diagnosed clinically – exploration
- Over 10 years (Raman et al. 2008)
  - Negative appendectomy 24% to 3%
  - Utilization rate 20% to 85%
- CT features
  - Dilated appendix (>8 mm)
  - Fluid filled
  - Inflammation
  - Fecolith
Acute Appendicitis

- Next step
- Surgical consultation
- Typically, no additional imaging
- Appendectomy
- Perforation
  - 2-10 fold increase mortality
  - Depending on severity – antibiotics, bowel rest, then surgery

Sigmoid Diverticulitis

- 10% < 40 yo, 60% > 80 yo have diverticulosis
- 10-20% that have diverticulosis will have diverticulitis
- Left sided – 90%

- CT helps classify and stage disease
- Abscess – 15% of cases

Sigmoid Diverticulitis

- Next step
- Uncomplicated Diverticulitis
  - Conservative management
  - Antibiotics
  - Diet Modification
- Complicated Diverticulitis
  - Mesocolic abscess – percutaneous drainage
  - Perforation, Peritonitis – Surgery consult
Sigmoid Diverticulitis

- Other complications
  - Pyelphlebitis
  - Hepatic abscess
  - Fistula
  - Peritonitis/sepsis
- Terminology
  - Intramural abscess
  - Micropereformation
  - Concentric muscular thickening

Bowel Obstruction

- Small vs. Large bowel
- SBO - Adhesion, hernia, neoplasm
- Radiograph – SBO - 69% sensitivity, 57% specificity
- CT – SBO – 94% sensitivity, 96% specificity
- Low-grade, high-grade, closed loop

Bowel Obstruction

- Etiology and severity will determine management
- 73% of patients treated conservatively will not recur
- 25% of patients presenting with SBO will undergo surgery
- CT sensitivity for low-grade obstruction is decreased
  - Partial
  - Intermittent
  - Ileus
Large Bowel Obstruction
- Cancer, sigmoid volvulus, diverticulitis
- CT sensitivity/specificity similar to SBO

Perforated Viscus Bowel Ischemia
- Peptic ulcer or diverticulitis
- Contained vs. Free
- CT will show site 86% of the time

- Occlusive vs. non-occlusive
- Risk factors
  - Atherosclerosis
  - Coagulopathy
  - Vasculitis
  - CT Angiography

Lower Abdominal Pain - Females
- DDx: Pelvic inflammatory disease; ovarian torsion, hemorrhagic cysts, ectopic pregnancy, endometriosis, uterine fibroids
- Clear, detailed history is critical
- Consider waiting for labs
- Transabdominal and transvaginal US
- If evaluation is incomplete, CT may be need for staging
Disease Spectrum

Natural history of frequent causes of an acute abdomen

- Life-threatening
  - Aortic aneurysm rupture
  - Pancreatitis
  - Bowel ischemia
  - Perforated peptic ulcer
- Self-limiting
  - Appendicitis
  - Cholecystitis
  - Sigmoid diverticulitis
  - Perforated diverticulitis
  - Gastroenteritis
  - Lymphadenitis
  - Epiploic appendagitis
  - Omental infarction
  - Cecal diverticulitis

Special Circumstances

- Age
- Size
- Renal Impairment
- Pregnancy

Age

- Pediatric Imaging
  - Can you avoid radiation?
  - Many start with US
  - Ensure use of weight/size based protocols
  - Exam cooperation
- Younger Patients (< 30 yo)
  - Single phase
  - Ask for low dose protocols
  - Frequent fliers

Can you avoid radiation?
Many start with US
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Ask for low dose protocols
Frequent fliers
Appendicitis Ultrasound
- Even with reduced dose, abdominal x-ray not the best first test in pediatric patients
- Graded compression US is first line
  - Sensitivity – 85%
  - Specificity – 92%
- Variable appendix location
- Perforation – Appendix only seen 40% of the time.
- Operator dependent
- Age consideration

Patient Size
- Obesity affects healthcare
- Scan table weight limits – 550-650 lbs
- Gantry/magnet size
  - CT – 70-90 cm
  - MR – 60-70 cm
- Oral Contrast – Young and very thin
- US probe selection

Renal Impairment
- CT – iodinated contrast can be nephrotoxic
  - ↑ incidence of contrast induced nephropathy with ↑ creatinine (>1.5 mg/dL)
  - eGFR < 30 ml/min/1.73 m²
- IV Hydration is the mainstay of prevention
- MRI – Gadolinium is not nephrotoxic but is associated with Nephrogenic Systemic Sclerosis (NSF)
  - eGFR < 30 ml/min/1.73 m²
  - Iodine is dialyzable, gadolinium is not
Renal Impairment
- Can US answer the question?
- Don’t hesitate to scan with CT without contrast
- Intrinsic contrast (i.e. intra-abdominal fat)
- ACR appropriateness criteria
- If you need image or luminal contrast, use MRI
- Non-contrast MR angiography

Pregnancy
- Ionizing radiation poses theoretical fetal risk of teratogenesis or carcinogenesis
  - Most susceptible < 15 weeks
  - Precautions – shielding, limited views, low dose settings
  - CT should be avoided – roughly double risk of childhood cancer
  - Good practice – pregnancy test prior to CT
  - MRI safety has not been established in pregnancy
    - Avoid elective MRI in pregnancy
    - No gadolinium given – Category C

Pregnancy
- RLQ pain – US may be preferred in early pregnancy
- MR finding increasing favor
  - Limited sequences
  - No contrast
- Identify alternative causes – pyelonephritis, nephrolithiasis, colitis, hemorrhagic cyst, pregnancy complications
Conclusions

- Initial choice of imaging modality is driven by history and clinical presentation
- US is great first line in RUQ pain, pediatric patients, and pregnancy
- CT is the primary imaging choice for most causes of abdominal pain.
- Understand the implications and severity of positive radiographic findings.
- Special circumstances such as renal impairment and pregnancy should alter your approach to imaging the abdomen.

Thank You! Questions?

References

- Sivit et al. 2001. When Appendicitis is Suspected in Children. Radiographics: Vol 21:1