Acute Abdominal Pain and Introduction to Imaging
Learning objectives

By the end of this activity, participants will be able to:

1. Describe the differential diagnoses for abdominal pain.
2. Understand the various imaging modalities.
3. Describe a suggested approach to reviewing abdominal radiographs.
4. Understand the imaging basics of appendicitis, diverticulitis, cholecystitis, renal stone disease, small bowel obstruction.
Outline

1. Background
2. Modalities
3. Cases !
4. Wrap up/Questions
Background

Acute abdominal pain: 5% of ER visits
• 10% of these patients have serious/life-threatening condition

H&P: first and most important step

Labs and imaging are supplementary
Common Causes Abd Pain

- Appendicitis
- Diverticulitis
- Cholecystitis
- Bowel obstruction
- Renal stones
- Perforation
- Intussusception
- Ischemia
- AAA rupture

This is not an all-inclusive list, but a very good start on the diseases we see in radiology!
Modalities: Radiography

• Acute abdominal series (AAS) - 3 views
  • AP supine abdomen
  • AP upright abdomen
  • PA upright chest

• Common indications:
  • Bowel perforation/free air
  • Obstruction

• Effective radiation dose: 0.1-1 mSv
Radiation Dose

Two types of effects:

1. Deterministic: at a certain dose burns, hair loss, skin necrosis WILL occur

2. Stochastic: increased risk with increased dose
   very rough estimate: 10mSv in an adult
   ~1/1000 risk of cancer
## Radiation Dose to Adults
### From Common Imaging Examinations

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Approximate effective radiation dose</th>
<th>Comparable to natural background radiation for</th>
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<tbody>
<tr>
<td><strong>ABDOMINAL REGION</strong></td>
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<tr>
<td>Computed Tomography (CT) — Abdomen and Pelvis</td>
<td>10 mSv</td>
<td>3 years</td>
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<tr>
<td>Computed Tomography (CT) — Abdomen and Pelvis, repeated with and without contrast material</td>
<td>20 mSv</td>
<td>7 years</td>
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<tr>
<td>Computed Tomography (CT) — Colonography</td>
<td>6 mSv</td>
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<td>Intravenous Pyelogram (IVP)</td>
<td>3 mSv</td>
<td>1 year</td>
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<td>Barium Enema (Lower GI X-ray)</td>
<td>8 mSv</td>
<td>3 years</td>
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<td>Upper GI Study With Barium</td>
<td>6 mSv</td>
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<tr>
<td><strong>BONE</strong></td>
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<td>Spine X-ray</td>
<td>1.5 mSv</td>
<td>6 months</td>
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<tr>
<td>Extremity (hand, foot, etc.) X-ray</td>
<td>0.001 mSv</td>
<td>3 hours</td>
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<td><strong>CENTRAL NERVOUS SYSTEM</strong></td>
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<tr>
<td>Computed Tomography (CT) — Head</td>
<td>2 mSv</td>
<td>8 months</td>
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<tr>
<td>Computed Tomography (CT) — Head, repeated with and without contrast material</td>
<td>4 mSv</td>
<td>16 months</td>
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<tr>
<td>Computed Tomography (CT) — Spine</td>
<td>6 mSv</td>
<td>2 years</td>
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<td><strong>CHEST</strong></td>
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<tr>
<td>Computed Tomography (CT) — Chest</td>
<td>7 mSv</td>
<td>2 years</td>
</tr>
<tr>
<td>Computed Tomography (CT) — Lung Cancer Screening</td>
<td>1.5 mSv</td>
<td>6 months</td>
</tr>
<tr>
<td>Chest X-ray</td>
<td>0.1 mSv</td>
<td>10 days</td>
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</tbody>
</table>
Modalities: AAS

- Acute abdominal series (AAS)
  - 3 views
    - AP supine abdomen
    - AP upright abdomen
    - PA upright chest

Common indications:
- Bowel perforation/free air
- Obstruction
Contrast

Various tissues attenuate the x-ray beam differently.

Hypodense or hypoattenuating
- Air
- Fat
- Soft tissue
- Bone
- Metal

Hyperdense or hyperattenuating
Modalities: CT

Rotating X-ray tube around patient
Allows for 2D images
(more on this in future lectures)

Higher radiation than AAS: 5-10 mSv

CT Abdomen and pelvis at UNC: recons in axial, coronal, and sagittal planes with soft tissue algorithm. Standard 5 mm axial slices
Iodinated contrast given IV
Contrast also given PO
Portal venous phase timed at 70 seconds post contrast injection
Contrast in the portal veins, hepatic veins, and IVC
Modalities: Ultrasound

Uses sound waves (rather than ionizing radiation)

Indications:
- RUQ pain: gallstones/cholecystitis/bile duct stones
- Appendicitis in kids/pregnancy
- Kidney stones
- Pelvis US for torsion/adnexal pain
Modalities: Ultrasound
Modalities: MR

Less frequently used modality in acute setting
Scan time >>> CT or US

Pros: Better soft tissue resolution

Cons: magnet safety, long scan time, $$$

Indications:
- Pregnant appy
- Suspect CBD obstruction after US = MRCP
- Problem solving
Outline

1. Background
2. Modalities
3. Cases
4. Wrap up/Questions
Case 1: RLQ Pain
Case 1: RLQ Pain

Dilated tubular structure in the right lower quadrant attached to the cecum. Few high density round structures at the appendix base appendicoliths.
Case 1: RLQ Pain

Appendicitis

CT in adults, US in kids

Imaging findings:
- dilated appendix >6mm
- Fat stranding
- Fluid
- Appendicolith
- +/- abscess

Dilated tubular structure in the right lower quadrant attached to the cecum. Few high density round structures at the appendix base appendicoliths
Case 2: Crampy LLQ Pain
Case 2: Crampy LLQ Pain

Colon: wall thickening, fat stranding in the region of multiple diverticula

Diverticulitis

CT test of choice

90% sigmoid

Imaging findings:
- Diverticulosis
- Fat stranding
- Bowel wall thickening
- +/- free air, abscess
Case 3: RUQ Pain

Recall normal GB in patient on the left
In the patient on the right, shadowing stone in the gallbladder, wall thickening, trace pericholecystic fluid
Case 3: RUQ Pain

Two important artifacts on ultrasound:
- Left: Posterior enhancement (enhanced through transmission)
- Right: Shadowing
Case 3: RUQ Pain

Cholecystitis

US initial modality; MRI or CT also used

Imaging findings:
- Wall thickening
- Gallstones
- Pericholecystic fluid
- Murphy’s sign on US
- +/- perforation
- Abscess

On US: Shadowing stone in the gallbladder, wall thickening, trace pericholecystic fluid
Case 3: RUQ Pain

On CT: Wall thickening, gallbladder mucosal enhancement, and pericholecystic fat stranding

Cholecystitis

US initial modality; MRI or CT also used

Imaging findings:
- Wall thickening
- Gallstones
- Pericholecystic fluid
- Murphy’s sign on US
- +/- perforation
- Abscess
Companion case:
Even on plain films!
Calcified gallstones in pt RUQ (majority of gallstones are not viz on xray however)
Case 4: Left flank pain

Presenting study: Three weeks prior:

Old study (right) with 3 mm calculus left kidney
Presenting study three weeks later dilated left renal collecting system
Case 4: Left flank pain

Dilated left renal collecting system
Stone now located in the proximal left ureter, causing obstruction

Stones get stuck most often at the UVJ
> UPJ > Iliac vessels
Case 4: Left flank pain

Dilated left renal collecting system
Stone now located in the proximal left ureter, causing obstruction

Nephrolithiasis

CT is often initial study of choice

US in kids, and radiographs for follow up

Imaging findings:
Stone +/- hydronephrosis
dilated ureter, inflammation
Case 5: Vomiting and abdominal distension

Dilated loops of small bowel on supine. Upright shows differential air fluid levels, with small bowel dilatation, absence of colon gas/stool.
Small bowel: plicae circulares

Large bowel: haustra
Case 5: Vomiting and abdominal distension

Small bowel obstruction SBO

Imaging findings:
- Dilated loops of bowel, >3 cm
- Air fluid levels
- Decompressed distal bowel and colon
- CT: transition point - hernia, adhesions, mass
Case 6: Currant jelly stool

US with color Doppler: target sign is made up of the multiple bowel wall layers of the intussusceptiens and intussusceptum.
Case 6: Currant jelly stool

Air enema is initial treatment for uncomplicated intussusception

Contraindications:
- perforation/free air
- peritoneal signs
- symptoms longer than 24 hours

Intussusception

3 months to 3 years old; US test of choice in kids

Imaging findings:
- Obstruction +/- right upper quadrant mass on radiograph

US: target sign
Case 6: Currant jelly stool

Air enema

Ileocolic intussusception is treated by radiologists.

Catheter inserted into rectum and taped for seal to prevent air leak.

Pump air into the colon maintaining pressure <120 mmHg until reduced.

Successful reduction – will see air reflux into the distal small bowel.
Pneumoperitoneum implies bowel perforation unless recent surgery. Left lateral decub can troubleshoot.
Case 8: Obtundation with hypotension

Axial CTs: Diffusely dilated loops of bowel. Air in the bowel wall = pneumatosis. Air in the SMV at the portal confluence
Case 8: Obtundation with hypotension

Ischemic bowel with pneumatosis

Imaging findings:

- Bowel wall thickening
- Pneumatosis is often late finding
- Gas in dependent bowel wall
- Can see gas in SMV/portal veins

Axial CTs: Diffusely dilated loops of bowel. Air in the bowel wall = pneumatosis.
Think Back!

- Common causes of abdominal pain we image
- Remember: US in children, radiographs/CT in adults
- But US in gallstones and cholecystitis!
- CT WITH contrast unless contraindication or suspect renal stone
- Intussusception Rx - air enema
- Any others? Any questions?
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Chief's Survey
RadExam
RSNA Physics Modules

UNC Radiology Conference schedule 18-19

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Thank you!
References
