Back to Basics:
What Imaging Test should I order?

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Disclosure

• Neither I nor any member of my immediate family has a relevant financial relationship or interest with any proprietary entity producing health care goods or services.

• The content of my presentation in this CME activity will not include discussion of unapproved or investigational uses of products or devices.
Objectives

• At the conclusion of the session the participant will be able to:
  • Order the appropriate upper gastrointestinal fluoroscopic examination for patients presenting with dysphagia, emesis, and possible aspiration
Objectives

• At the conclusion of the session the participant will be able to:
  • Order the appropriate imaging for patients presenting with appendicitis, bowel obstruction, and inflammatory bowel disease
Objectives

• At the conclusion of the session the participant will be able to:
  • Order the appropriate imaging for the evaluation of soft tissue masses
Objectives

• At the conclusion of the session the participant will be able to describe:
  • The common indications for IV contrast in CT Imaging of the Chest
  • The common indications for IV contrast in MR imaging of the Abdomen and Musculoskeletal system
Fluoroscopy

- Common Indications
  - Possible aspiration
  - Dysphagia
  - Evaluate for Reflux
  - Emesis (+/- bilious)
  - Foreign Body

- Procedures
  - Modified Swallow/Swallow Function
  - Esophagram
  - Upper GI Series
  - Small Bowel Follow Through
What is a Modified Swallow?

- Dynamic evaluation of the oropharyngeal phase of swallowing (Mouth and cervical esophagus)
- Performed with a speech pathologist
- Utilizes various consistencies of barium including thin and thickened liquids, as well as purees and solids
- Evaluation of swallowing strategies
When should I request a Modified Swallow?

• Choking with feeds
• Newborn post-op for congenital heart disease
• Concern for aspiration after Neurologic insult
What is an Esophagram?

- Fluoroscopic evaluation from the pharynx to the gastroesophageal junction
- May involve rapid sequence imaging of the cervical esophagus in the AP projection
When should I request an Esophagram?

- Dysphagia or “Food sticking”
- Suspected stricture
- Suspected esophageal foreign body
- Concern for tracheoesophageal fistula
What is an UPPER GI Series?

- Fluoroscopic examination inclusive of the esophagus, stomach, and duodenum to the duodenojejunal junction
- Requires the patient to be NPO
- Ideally, performed first thing in the morning
When should I request an UPPER GI SERIES?

• Concern for Reflux
• Concern for Hiatal Hernia
• Concern for Malrotation
• Concern for Gastric Outlet Obstruction
• Evaluation for potential G-tube
• Evaluation of Nissen fundoplication
Malrotation

• Does not need a Small Bowel Follow Through!
• UGI is adequate for evaluation of duodenojejunal junction!
Small Bowel Follow Through

• Frequently ordered rarely indicated!!

• Utility limited to feeding intolerance post Necrotizing enterocolitis – Post op infants

• Virtually obsolete for bowel obstruction or Crohn’s disease
Imaging of Suspected Appendicitis: Goals

- Identify or exclude appendicitis
- Identify alternative diagnosis
- Identify complications which may alter management
  - Perforation
  - Abscess formation
Imaging of Appendicitis

• KUB - No role
• Findings are typically non-specific
  • Localized ileus
  • Bowel obstruction
  • Soft tissue mass
  • Calcified appendicolith, most specific finding, is only seen in ~ 5% of children with appendicitis
Acute RLQ Abdominal Pain: ACR Appropriateness Criteria

<p>| Variant 4: | Fever, leukocytosis, possible appendicitis, atypical presentation in children (less than 14 years of age). |</p>
<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
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<tbody>
<tr>
<td>US abdomen RLQ</td>
<td>8</td>
<td>With graded compression. May be useful following negative or equivocal US. Use of oral or rectal contrast depends on institutional preference. Consider limited RLQ CT.</td>
<td>O</td>
</tr>
<tr>
<td>CT abdomen and pelvis with contrast</td>
<td>7</td>
<td></td>
<td>⭐⭐⭐⭐⭐</td>
</tr>
<tr>
<td>X-ray abdomen</td>
<td>6</td>
<td>May be useful in excluding free air or obstruction.</td>
<td>⭐⭐</td>
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<tr>
<td>US pelvis</td>
<td>5</td>
<td></td>
<td>O</td>
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<td>CT abdomen and pelvis without contrast</td>
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<td>Use of oral or rectal contrast depends on institutional preference. Consider limited RLQ CT.</td>
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<td>MRI abdomen and pelvis without and with contrast</td>
<td>5</td>
<td>See statement regarding contrast in text under “Anticipated Exceptions.”</td>
<td>O</td>
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<td>CT abdomen and pelvis without and with contrast</td>
<td>4</td>
<td>Use of oral or rectal contrast depends on institutional preference. Consider limited RLQ CT.</td>
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<td>MRI abdomen and pelvis without contrast</td>
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<td></td>
<td>O</td>
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<tr>
<td>X-ray contrast enema</td>
<td>3</td>
<td></td>
<td>⭐⭐⭐⭐</td>
</tr>
<tr>
<td>Tc-99m WBC scan abdomen and pelvis</td>
<td>2</td>
<td></td>
<td>⭐⭐⭐⭐</td>
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Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level
Difficult Sonographic Diagnosis

• Operator Dependent

• Variability of Appendix position

• Gas in the way

• Body habitus

• Pre-test Probability
Appendicitis in the Very Young

• < 3 y.o. – Delayed presentation – ruptured appendicitis

• V/D, fever, abd pain often for 3 - 4 days (Diarrhea common in very young with appendicitis, not older children and adults)

• Often present with peritonitis and small bowel obstruction
US vs. CT: Meta-analysis

- US: Sensitivity 88%, Specificity 94%
- CT: Sensitivity 94%, Specificity 95%
- US followed by CT in equivocal US cases: Sensitivity and Specificity 94%

Cooke and Blackmore, “Imaging of Appendicitis in Pediatric Patients” in Evidence Based Imaging in Pediatrics. 475-486
US vs. CT: Effect of Body Habitus

• BMI limits visualization of appendix by US
  • 79% nonvisualization in overweight children
  • 33% nonvisualization in normal weight children
  • 25% nonvisualization in underweight children

• BMI improves visualization of normal appendix by CT
Imaging of Appendicitis

• Protocol of US followed by CT in negative or equivocal subjects may achieve similar sensitivity and specificity to CT alone, but with less radiation exposure

• US followed by CT may also be a cost-effective imaging strategy
Imaging of Suspected Bowel Obstruction

• Initial Abdominal Series
  • 2 Abdominal views – Supine and Horizontal beam
  • Upright Chest Radiograph
Acquired Small Bowel Obstruction in Children

AIM x 2
Acquired Small Bowel Obstruction in Children

- Adhesions
- Inguinal Hernia
- Malrotation/Midgut Volvulus
- Appendicitis
- Intussusception
- Meckel’s Diverticulum

- Miscellaneous
# Imaging of Acquired Small Bowel Obstruction

**American College of Radiology**  
**ACR Appropriateness Criteria®**

**Clinical Condition:** Suspected Small-Bowel Obstruction  
**Variant 1:** Suspected high-grade small-bowel obstruction (SBO), based on clinical evaluation or initial radiography (if performed).

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<td>CT abdomen and pelvis with IV contrast</td>
<td>9</td>
<td>Oral contrast should not be used if high-grade SBO is known or suspected. Oral contrast will not reach the site of obstruction, wastes time, adds expense, can induce further patient discomfort, will not add to diagnostic accuracy, and can lead to complications, particularly vomiting and aspiration.</td>
<td>☀ ☀ ☀ ☀</td>
</tr>
<tr>
<td>CT abdomen and pelvis without IV contrast</td>
<td>7</td>
<td>Perform this procedure in patients who have known or suspected high-grade SBO when IV contrast is contraindicated.</td>
<td>☀ ☀ ☀ ☀</td>
</tr>
<tr>
<td>MRI abdomen and pelvis without and with IV contrast (routine)</td>
<td>6</td>
<td>MRI is most appropriate in children and younger adult patients who have had multiple prior CT examinations.</td>
<td>☀</td>
</tr>
<tr>
<td>X-ray abdomen and pelvis</td>
<td>5</td>
<td>Perform this procedure if it has not already been performed.</td>
<td>☀ ☀ ☀ ☀</td>
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Inflammatory Bowel Disease

• In pediatric population
  • Incidence of UC = 2/100,000
  • Incidence of Crohn’s Disease = 4.5/100,000

• 25% of all IBD presents in pediatric age group
IBD: What do clinicians need from imaging?

- Distribution and severity of Intraluminal and Extraluminal Disease
- Identify surgical candidates
IBD: What do clinicians need from imaging?

• Assess Complications:
  • Lymphadenopathy
  • Fistula/sinus formation
  • Abscess
  • Stricture formation
IBD

• Acute Inflammation
• Fibrosis
• Penetrating Disease

Surgical
## Crohn Disease: ACR Appropriateness Criteria

**Clinical Condition:** Crohn Disease  
**Variant 2:** Child or young adult. Initial presentation. Suspected Crohn disease.

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<td>CT abdomen and pelvis with contrast (CT enterography)</td>
<td>9</td>
<td>MR enterography may have sensitivity and specificity similar to CT enterography and avoids radiation risks. However, the choice of examination depends on institutional preferences and resources. MRI is the preferred modality for investigating perianal disease. See statement regarding contrast in text under &quot;Anticipated Exceptions.&quot;</td>
<td>✔</td>
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<td></td>
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<td>7</td>
<td></td>
<td>✔</td>
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<tr>
<td>X-ray small-bowel follow-through</td>
<td>7</td>
<td>The RRL for the adult procedure is</td>
<td>✔</td>
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<td>US abdomen and pelvis</td>
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<td>The RRL for the adult procedure is</td>
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<td>X-ray abdomen</td>
<td>5</td>
<td>May be useful to exclude free air if perforated hollow viscus is suspected.</td>
<td>✔</td>
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<td>Tc-99m HMPAO leucoscintigraphy</td>
<td>3</td>
<td></td>
<td>✔</td>
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<tr>
<td>US pelvis endorectal</td>
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**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

**Relative Radiation Level**
Crohn Disease: ACR Appropriateness Criteria

Clinical Condition: Crohn Disease

Variant 4: Child or young adult with known Crohn disease; acute exacerbation such as fever or increasing abdominal pain or leukocytosis.

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<td>CT abdomen and pelvis with contrast (routine)</td>
<td>9</td>
<td>Routine CT may be acceptable to detect abscess or bowel obstruction if patient is unable to drink the volume of contrast required for enterography.</td>
<td>☺☺☺☺</td>
</tr>
<tr>
<td>CT abdomen and pelvis with contrast (CT enterography)</td>
<td>9</td>
<td>Consider dose reduction techniques.</td>
<td>☺☺☺☺</td>
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<tr>
<td>MRI abdomen and pelvis without and with contrast (MR enterography)</td>
<td>9</td>
<td>MR enterography may have sensitivity and specificity similar to CT enterography and avoids radiation risks. However, the choice of examination depends on institutional preferences and resources. MRI is the preferred modality for investigating perianal disease. See statement regarding contrast in text under “Anticipated Exceptions.”</td>
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*Relative Radiation Level
Imaging in Crohn’s

• CT or MRE – Acutely ill patient
  • Suspected High Grade Obstruction
  • Suspected Abscess
  • Suspected Perforation
Imaging in Crohn’s

- MR Enterography – Follow-up, relapse
  - Suspected stricture
  - Surgical planning
  - Treatment failure
  - Assessment of Perianal disease
Imaging of Soft tissue Masses

- Initial Evaluation – Ultrasound
- MR if concerning ultrasound features
- MR if infiltrating or consistent with vascular malformation
CT Imaging of the Chest

• Most Cases non-contrast imaging is appropriate
  • Infection
  • Atelectasis
  • Airway abnormality
  • Immunosuppression/Neutropenia
  • Interstitial Lung disease / Cystic Fibrosis
  • Pectus Deformity
Indications for IV Contrast in Chest CT

• Mediastinal Abnormality
• Suspected Malignancy
• Complicated Pneumonia with suspected Pleural Disease (Empyema)
• Suspected Congenital Abnormalities
  • CPAM
  • Sequestration
Indications for IV Contrast in Chest CT

• Special Case: Suspected Pulmonary Embolus
  • Large Bore IV
  • Requires large and tight bolus of IV Contrast
  • Scanned from bottom up instead of top down in routine Chest CT
Indications for IV Contrast in MR of the Abdomen

• In Most cases IV Contrast is indicated
  • Evaluation of Tumor/Malignancy
  • Evaluation of Infection
  • MRCP – Biliary Tree and Pancreas
  • MR Enterography
Musculoskeletal MR

• Non IV Contrast Imaging
  
  • Joints – Suspected Internal Derangement

• Shoulder- Often requires Arthrogram – injection of contrast into the joint
Musculoskeletal MR

- IV Contrast typically required
  - Mass/Tumor evaluation
  - Suspected Infection
    - Osteomyelitis
    - Myositis
  - Suspected Juvenile Idiopathic Arthritis
  - Suspected Vascular Malformation
Conclusions
Fluoroscopy

• Common Indications
  • Possible aspiration
  • Dysphagia
  • Evaluate for Reflux
  • Emesis (+/- bilious)
  • Foreign Body

• Procedures
  • Modified Swallow/Swallow Function
  • Esophagram
  • Upper GI Series
  • Small Bowel Follow Through
Imaging of Appendicitis

- Ultrasound followed by CT if necessary
- CT if suspected rupture/abscess
- MR - Future
Imaging of Acquired Small Bowel Obstruction

- AIM x 2

- Ultrasound in suspected appendicitis and intussusception

- CT of the Abdomen with IV contrast only
 Imaging in Crohn’s

- CT or MRE – Acutely ill patient
  - Suspected High Grade Obstruction
  - Suspected Abscess
  - Suspected Perforation
Imaging in Crohn’s

- MR Enterography – Follow-up, relapse
  - Suspected stricture
  - Surgical planning
  - Treatment failure
  - Assessment of Perianal disease
Imaging of Soft Tissue Masses

- Ultrasound for initial evaluation
- Rarely CT, more commonly MR if aggressive, infiltrating, or suspected vascular malformation
IV Contrast in CT of the Chest

• Non contrast in primary pulmonary disease
• Contrast needed in
  • Suspected malignancy
  • Mediastinal Abnormality
  • Complicated Pneumonia (Empyema)
  • Suspected Congenital Abnormality
IV Contrast in MR

- Suspected Tumor
- Suspected Infection
- Hepatobiliary Imaging
- MR Enterography
- Suspected Vascular Malformation
- Active Arthritis
When in Doubt?

Call your friendly neighborhood Pediatric Radiologist!