**Imaging of the Vomiting Infant**

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**Challenges of Imaging Children**

- History and physical exam less reliable
- Choosing the best initial modality
  - Organ of interest
  - Age of the patient
    - Differing pathology
    - Patient cooperation
- Safety issues

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**Abdominal Pain in Infants and Children**

- History and physical findings overlap
  - Diarrhea
  - Blood in stool
  - Episodic crying
  - Poorly localized pain
- Pathologies cluster in specific age groups
  - Newborn
  - 1 week – 2 months
  - 2 - 5 months
  - 5 months – 2 years
  - 2 yrs - adolescence

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I have no financial conflicts to disclose.
**Vomiting - 1 to 8 Weeks of Age**

- Gastroesophageal reflux
- Gastric outlet obstruction
  - Pyloric muscle
  - Spasm
  - Hypertrophy

**Hypertrophic Pyloric Stenosis**

- Infants 3-6 weeks of age
- Projectile vomiting
  - Non-specific
- Contrast UGI series
  - Can show obstruction
  - Unreliable for GER or muscle thickness
- US is best modality
  - 7-12 mHz transducer

**Normal Pylorus**

- 1-2 mm muscle
- Length negligible
- Opens frequently

**Hypertrophic Pyloric Stenosis**

- 3 mm + muscle
- 1.5 cm + length
- Decreased emptying
**Pylorospasm**
- Persistent contraction of the antropylorus
- Emptying may be absent
- Muscle can measure between 2-2.9 mm
- Treat medically
  - Follow with US if symptoms increase

**Pitfall – the empty stomach!**
- Administer fluid (sugar water), if needed
- Oblique patient to right

**Congenital/Developmental Abnormalities**
- Incomplete duodenal obstruction
  - Diaphragm
  - Stenosis
- Acute duodenal obstruction
  - Midgut volvulus
- Colon obstruction
  - Hirschprung disease
3 month old with increasing vomiting

Duodenal Web (missed on initial UGI series)

Duodenal Web
- Incomplete obstructing band
- Second portion of duodenum
- Increased incidence with Trisomy 21
Annular Pancreas

17 year old with new onset abdominal pain with meals

Jejunal Stenosis

Midgut Volvulus

- Acute obstruction
- Minimal findings on radiographs
- Contrast exams versus US

Obstruction 3rd portion of duodenum = midgut volvulus

SMV normally lies to the right of SMA
1 week old with vomiting

Recurrent vomiting 2 wks s/p Ladd’s procedure

7% recurrence rate

Midgut Volvulus

What study would you do next?

Majority of small bowel was ischemic

Abdominal Heterotaxy and Volvulus

- High incidence of malrotation in children with abdominal heterotaxy

Duodenojejunal junction and cecum on same side of abdomen may indicate risk
Low-lying Ligament of Treitz
May indicate malrotation if cecum is in abnormal location

2 week old with bilious vomiting
• What study would you do next?

Hirschprung Disease – Abnormal rectosigmoid ratio

Hirschprung Disease
• Aganglionic segment contracted
• Abnormal rectosigmoid index, but beware higher transition zone
• Bizarre contractions common
Transition zone can be subtle in young infants

5 months to 2 years
- Ileocolic intussusception
  - Episodes of crying
  - Vomiting
  - Drawing up legs
  - Lethargy
  - Bloody (current jelly) stools
  - Palpable abdominal mass

Intussusception
- Causes
  - Lead points
    - Meckel’s diverticulum
    - Polyps
    - Intestinal duplication cyst
  - Lymphoma
  - Henoch-Schoenlein purpura
  - Post-operative
- Most are idiopathic
  - Gastroenteritis/hyperperistalsis

Idiopathic Intussusception
- Viral infection or other inflammatory bowel condition
  - Thickened wall or mucosa
  - Hypertrophied Peyer’s patches
  - Hyperperistalsis
**Signs and Symptoms**

- Crampy abdominal pain
- Irritability
- Vomiting
- Bloody stools
- Lethargy
- Palpable abdominal mass

**Radiographs**

- May be suggestive but often non-specific
  - Mass effect along course of colon
  - Target sign
  - Small bowel obstruction

Always be suspicious of absent gas in the right colon

Prone radiographs may help
9 month old with bilious vomiting and fever

Ultrasound for Intussusception
- High frequency (7-12 mHz) transducer
- Complex mass
  - Target, donut appearance

• High sensitivity and specificity
• If US negative, contrast enema not needed

Lack of flow with Doppler suggests ischemia, but not a contraindication to non-surgical reduction

Transient Intussusception
- Common in patients with hyperperistalsis
- Only need surgery if persistent and longer than 3.5 cm in length

Munden, AJR 2007;188:275-279
Non-surgical Reduction

- Few contraindications
  - Peritoneal signs
  - Free air on radiographs
- Free fluid not a contraindication
- Enema reduction
  - Hydrostatic
    - Fluoroscopy vs. US
  - Air

Signs of Difficult Enema Reduction

- Symptoms for more than 48 hours
- Age under 3 months
- Small bowel obstruction
- Target rim > 1 cm in thickness
- Large amount of trapped fluid
- Distal migration of intussusceptum

Air Enema Reduction

- Advantages
  - Faster (less radiation)
  - Less messy
  - Higher reduction rate
  - Smaller hole and less contamination with perforation
Ileo-ileocolic Intussusception

Can be more difficult to identify residual ileo-ileal intussusception

Perforation

- Keep below 120 mm Hg to avoid perforation

Perforation

- Keep a 21 gauge spinal needle handy, in case decompression is needed
Recurrent Intussusception

- Occurs in about 10% of cases
  - Same for air or fluid reduction
- Repeat enema reduction is safe and effective
- Multiple recurrences – consider a lead point

Intussusception Lead Points

- Present in about 5-6% of childhood cases
- More common in newborns, children > 3 years
- US may identify lead point (66%)
- Enema reduction may be requested
  - Decreases surgical incision

You’re A Success!

- Two things left to do:
  - Monitor patient for 24 hours for recurrence
  - Enjoy personal satisfaction and gratitude from family and surgeon

Appendicitis in Young Children

- Uncommon, but does occur
- Must differentiate from other conditions
  - Mesenteric adenitis
  - Ileocolitis/gastroenteritis
  - Henoch-Schoenlein purpura
  - Hemolytic uremic syndrome
US for Appendicitis

- Still accepted as best first screening exam
- Staged approach using CT for equivocal cases highly accurate
  - Sensitivity 98.6%
  - Specificity 90.6%
  - CT avoided in 53%
  Krishnamoorthi, Radiol Jan. 2011

Appendix Size in Appendicitis

- 6 mm or > in diameter “abnormal”
  - PPV – 63%
  - NPV – 100%
  - More useful for excluding appendicitis
  Rettenbacher, Radiology 2011; 218: 757.
- 7 mm or >
  - Similar accuracy

Compressibility – can be difficult to demonstrate with normal appendix

Normal Appendicitis

Acute suppurative appendicitis

Normal appendix
Follow the Appendix to the Tip

Non-perforated tip appendicitis

Perforated Appendix

- Dilated small bowel
- RLQ mass
- Colon cut-off
- Flank stripe

Signs of Active or Impending Perforation

- Loss of mucosal lining
- Edematous fat
- Adjacent fluid collections

Complex free fluid = peritonitis

Secondary findings can be strong indicators of appendicitis


Thickened Echogenic Fat = Inflammation
Abscesses Mimic Other Pathologies

- Hematometrocolpos
- Abscess from perforated appendicitis
- Abscess can be mistaken for bladder on US

Abdominal/Pelvic CT in Children

- IV contrast – 2cc/kg
- Oral or rectal contrast not always needed
- Coronal, sagittal reconstruction
- Take measures to reduce radiation exposure

Advice for Decreasing Dose in Pediatric CT

- “Child-size” your CT (kVp, mA)
- Pediatric protocols on IG website (www.imagegently.org)
  - Work with your technologists to implement
- Scan only when necessary
  - Must develop better definitions of “necessary”
- Scan only the indicated region
  - Requires point of care protocoling
- Scan only once
  - Delayed imaging for trauma scans should be restricted to those cases with high risk injuries on initial pass images
Challenges with CT
• Lack of intra-abdominal fat

Ultrafast 3T MRI for Appendicitis
• 42 children
  – Ages 4-17
• No sedation or contrast
• TSE sequences w/wo fat saturation
• Scan times less than 9 minutes
• Normal appendix seen 43% of the time
• Sens/spec 100/99%
  – PPV 98%
  – NPV 100%
Johnson, AJR 2012, Jun 198:1424

Calcified appendicolith with distal obstruction
11/17/2015

**Abdominal Emergencies in Young Children**

- Age appropriate diagnoses
- Multi-modality imaging often needed
  - Use ultrasound whenever possible
  - Lower the dose when using CT
  - Consider MRI when US not diagnostic

**Unexpected Diagnoses**

- 5 yr old with abdominal pain, fever, and vomiting
- Left Lower Lobe Pneumonia

**3 yr 11 month old with normal appendix**

**8 month old with vomiting, distended abdomen**

Perforated jejunum caused by blunt trauma (child abuse)

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