Acute Pediatric Abdomen

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Conflict of Interests

- None
Goals

• Review common causes of the acute surgical abdomen in children
• Discuss US and CT findings in the acute surgical abdomen
• (Imaging techniques)
Acute Abdominal Pain

Surgical

- Appendicitis
- Volvulus
- Ovarian torsion
- (Intussusception)
- Incarcerated hernia

Medical

- Pyelonephritis
- Constipation
- Enteritis
- Mesenteric adenitis
- Pelvic inflammation
- Pneumonia
Surgical Causes of Acute Abdominal Pain

• Infants and children < 3 years
  – Malrotation
  – Intussusception

• Older children
  – Acute appendicitis
  – Ovarian torsion
Midgut Malrotation

• Anomaly of bowel fixation & rotation
  – short mesentery
• 80% of patients present in first month
• Clue: biliary vomiting
• Surgical emergency
Malrotation: Plain Xrays

- Not really useful
  - Normal
  - Non-specific gas pattern
  - Duodenal obstruction
  - Low small bowel obstruction
Malrotation

- UGI is gold standard
- Findings
  - Duodenal obstruction
    » 2nd - 3rd duodenum
  - Spiral appearance of duodenum (volvulus)
  - Jejunum in RUQ
Malrotation

- Enema is no longer routine because
  - 20% of patients with malrotation have a cecum in RLQ
  - 15% of normal patients have a high mobile cecum (common variant)
- Poor sensitivity & specificity
What about US & CT?

- NOT primary studies for diagnosis
- BUT findings incidentally detected, so you need to recognize them
  - SMA/SMV inversion (malrotation)
  - twisting of SMV around SMA (volvulus)
Malrotation: Treatment

• Ladd operation
• Resection of peritoneal bands and nonviable bowel
• Reduction of volvulus
• Placement of small bowel in the right abdomen and colon in the left abdomen
Intussusception

- Age 3 months to 3 yrs
- Classic triad
  - Colicky abdominal pain
  - Vomiting
  - Bloody stools
- 90% ileocolic
- Lead mass 2% to 17%
  - children > 3 years
Intussusception: X-rays

- Soft tissue mass RUQ
- Paucity RLQ bowel gas
- SBO
- OR non-specific
Intussusception: US

- Graded compression
- Transverse scan
  - alternating bright & dark rings
  - target, bull’s eye sign
- Longitudinal scan
  - pseudokidney sign
Intussusception: Color Doppler

- Positive blood flow
  - Reduction rate 94%
  - Viability 100%
- Absent flow
  - Reduction rate 0%
  - Necrosis 100%

Lim et al. Radiol 1994; 191:781
Intussusception: US

- Sensitivity: 94 to 100%
- Specificity: 88 to 100%
- False-positive diagnoses
  - fecal contents
  - inflammatory bowel disease
  - intramural hematoma
Intussusception Treatment: Enema reduction

• Air up to 120 mm Hg or water soluble contrast
• 3 attempts, 3-5 minutes each
• Endpoint is reduction of soft tissue mass **AND** rush of air or contrast into the SB
• Contraindication: peritonitis
Appendicitis

• Most frequent condition requiring urgent surgery
• Result of luminal obstruction, vascular engorgement, and bacterial overgrowth
• Rare in infancy (< 0.2% of cases)
• Frequency increases after one year of age (peak 12 to 15 years)
Imaging Options

• Plain radiographs
  – neither sensitive nor specific
  – of 821 consecutive patients hospitalized for appendicitis, X-rays abnormal in 51% with and 47% without appendicitis (p=0.0075)

• Ultrasonography

• Computed Tomography

Appendicitis: US Features

- Noncompressible blind-ending tube
  - Diameter $\geq 6$ mm
- Appendicolith
- Periappendiceal fluid
Appendiceal Perforation

- 20 to 40% of cases
- 24 to 48 hours after onset of symptoms
- US findings
  - Periappendiceal thickening
  - Abscess
- May not see the appendix if it perforates
Appendicitis: Color Doppler US

- Increases confidence in diagnosis
- Normal soft tissues are avascular
- Non-perforated
  - Peripheral appendiceal flow 87%
  - Hyperemic soft tissues 7%
- Perforated
  - Hyperemic soft tissues 50%
  - Abscess formation 35%
Pitfalls: US

• False-negative (5%)
  – Retrocecal appendix
  – Perforation

• False-positive (5%)
  – Normal appendix
  – Other bowel diseases
Normal Appendix

- 5 to 10% frequency
- < 6 mm in diameter
- Central echogenic stripe (mucosa)
- Compressible
- No or trace color flow
## US of Appendicitis

<table>
<thead>
<tr>
<th></th>
<th>Sens %</th>
<th>Spec %</th>
<th>Accuracy</th>
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<tbody>
<tr>
<td>Puylaert (1986)</td>
<td>89</td>
<td>100</td>
<td>95</td>
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<tr>
<td>Vignault (1990)</td>
<td>94</td>
<td>89</td>
<td>91</td>
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<tr>
<td>Quillin (1994)</td>
<td>87</td>
<td>92</td>
<td>90</td>
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<tr>
<td>Garcia-Pena (1999)</td>
<td>44</td>
<td>93</td>
<td>76</td>
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Appendicitis: CT

- Advantage: Not operator dependent
- Children:
  - Sensitivity 97%
  - Specificity 94%
- Indications
  - Obese patients
  - Delineate abscess extent
  - Guide abscess drainage
Pitfalls: CT

- False-negative
  - Highly unlikely
- False-positive
  - Normal appendix
  - Other bowel diseases
Appendicitis: CT

• Abnormal appendix
  – 8 to 12 mm diameter
  – Wall enhancement

• Normal appendix
  – 6- 8 mm diameter
  – Thin wall
  – No enhancement
## Differential Diagnosis

### 178 Children (US)

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>No.</th>
<th>US TP</th>
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</thead>
<tbody>
<tr>
<td>Appendicitis</td>
<td>38 (22%)</td>
<td>82%</td>
</tr>
<tr>
<td>Gynecologic</td>
<td>25 (14%)</td>
<td>72%</td>
</tr>
<tr>
<td>GI/Biliary</td>
<td>17 (10%)</td>
<td>76%</td>
</tr>
<tr>
<td>Renal</td>
<td>6 (3%)</td>
<td>50%</td>
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<tr>
<td>Other</td>
<td>10 (5%)</td>
<td></td>
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<tr>
<td>None made</td>
<td>82 (46%)</td>
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</tbody>
</table>
Gynecologic Diseases

- Hemorrhagic cyst
- Ovarian torsion
- (Pelvic inflammatory disease)
Hemorrhagic Ovarian Cyst

- **US Findings**
  - Complex mass
    - Internal echoes
    - Fluid-levels
  - Ovary not enlarged
    - No peripheral cysts
  - Involutes
Adnexal Torsion of Normal Ovary

• US/CT features:
  – Ovarian enlargement
  – Multiple peripheral cysts
• No flow as a rule
  – BUT CAN OCCUR BECAUSE OF DUAL BLOOD SUPPLY
Gastrointestinal Disease

- 10% alternative diagnoses
- Includes
  - Bowel disease (Crohn, infection, vasculitis
  - Mesenteric adenitis
  - Intussusception
- Gray-scale sensitivity 75%
  - FN: early or mild inflammation
Bowel Disease

- Usually small bowel
- Thickened bowel wall
  - 4-6 mm
- Slightly compressible
- No blind-ending
- Hypervascular
Mesenteric Adenitis: Imaging

- > 3 LN in RLQ or in mesenteric root
- > 5 mm in short axis
Summary: Surgical Abdomen

• Common causes of a surgical abdomen in children have distinct imaging features

• You need to recognize these

There are clues!