A case of acute appendicitis in a pediatric patient

Vanessa Chen, MS4
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Dr. Ceren Yalniz, Fellow in Diagnostic Imaging

UTHealth McGovern Medical School
Clinical History

- 6 y.o. male with no PMH/PSH presenting with approximately 1.5 days of abdominal pain
  - Pain began in right upper thigh, moved to umbilicus, then spread diffusely
  - Currently radiates to RLQ

- Current symptoms:
  - Endorses fever up to 103.1 F, anorexia
  - Denies nausea, vomiting, chills

- Physical exam findings:
  - Vitals: 100.7 F, HR: 129, RR: 22, BP: 113/68, SpO2: 96%
  - General: in significant pain?
  - Abdomen: soft, +pain on palpation, +pain with movement, +rebound, +guarding, -masses/hernias/scars/hepatosplenomegaly

- Work-up (notable labs):
  - CBC from OSH: WBC 15.2 with 73% PMNs
US Abdomen Limited – Right Lower Quadrant

- 10/29/2019 grayscale longitudinal ultrasound of RLQ

- Appendicolith
- Posterior shadowing
- Bladder
- Lumen of appendix
More relevant imaging

- 10/29/2019 grayscale longitudinal ultrasound of RLQ

- Dilated, non-compressible appendix
- Heterogenous appearance of appendix indicating inflammation
More relevant imaging

- 10/29/2019 color Doppler longitudinal and trans ultrasound of RLQ

- Bladder
- Hyperemic appendix (in musculature of appendix)
- Iliac artery/vein
- Iliac artery
- Iliac vein
- Appendicolith
More relevant imaging

• 10/29/2019 grayscale longitudinal ultrasound of RLQ and LLQ

FF = Free fluid, which is indicative of inflammation
US – Abnormal Appendix

Target sign on axial plane ultrasound with 9 mm diameter
Summary of Key Imaging Findings

• CC: RLQ abdominal pain, fever, leukocytosis

• Imaging findings:
  • RLQ transducer tenderness with compression
  • Appendix visualized with diameter of 1.57 mm
  • No periappendiceal fat infiltration
  • Appendicolith present
  • Appendix hyperemic
  • Appendix non-compressible
  • Small amount of simple free fluid in bilateral lower quadrants
Differential Diagnosis: Acute Abdominal Pain in Children

• Gastroenteritis
  • Most common cause of abdominal pain in children
  • Viral: Rotavirus, Norwalk virus, adenovirus, enterovirus
  • Bacterial: E. coli, Yersinia, Campylobacter, Salmonella, Shigella

• Mesenteric lymphadenitis
  • Associated with Adenovirus infection
  • Mimics appendicitis
  • No signs of peritonitis, less localized
  • +/- generalized lymphadenopathy

• Urinary tract infection
  • Urinary frequency, dysuria, urgency, malodorous urine
Final Diagnosis: Simple Acute Appendicitis

• Most common surgical condition in children with abdominal pain
• Definition: inflammation of the veriform appendix
  • Subtypes: simple vs complicated (presence of gangrene/perforation)
• Pathophysiology: obstruction of appendiceal lumen by lymphoid tissue or fecalith leads to distension, ischemia, necrosis
• Presenting signs: visceral pain = vague, poorly localized, periumbilical
  • 6-48 hours: parietal pain (peritoneum inflamed) = well localized and constant in right iliac fossa
• PAS score for our patient: 9/10
Discussion: Samuel’s Pediatric Appendicitis Score (PAS)

• For use in patients age 3-18 with abdominal pain less than/equal to 4 days’ duration

• Do NOT use if known GI disease, pregnancy, previous abdominal surgery

• Stratifies to: Low Risk PAS (<4), Equivocal PAS (4-6), High Risk PAS (>6)
  • Low Risk $\rightarrow$ consider other causes
  • Equivocal $\rightarrow$ imaging helpful, surgical consult warranted
  • High Risk $\rightarrow$ surgical consult

• Found to be 98.6% sensitive, 94.4% specific
  • Helped decrease need for CT from 75.4% to 24.2%\textsuperscript{5}
## PAS Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RLQ tenderness to cough, percussion, or hopping</td>
<td>No 0</td>
<td>Yes +2</td>
</tr>
<tr>
<td>Anorexia</td>
<td>No 0</td>
<td>Yes +1</td>
</tr>
<tr>
<td>Fever</td>
<td>No 0</td>
<td>Yes +1</td>
</tr>
<tr>
<td>Temp ≥38.0°C/100.4°F</td>
<td>No 0</td>
<td>Yes +1</td>
</tr>
<tr>
<td>Nausea or vomiting</td>
<td>No 0</td>
<td>Yes +1</td>
</tr>
<tr>
<td>Tenderness over right iliac fossa</td>
<td>No 0</td>
<td>Yes +2</td>
</tr>
<tr>
<td>Leukocytosis</td>
<td>No 0</td>
<td>Yes +1</td>
</tr>
<tr>
<td>WBC &gt;10,000</td>
<td>No 0</td>
<td>Yes +1</td>
</tr>
<tr>
<td>Left shift</td>
<td>No 0</td>
<td>Yes +1</td>
</tr>
<tr>
<td>ANC &gt;7,500</td>
<td>No 0</td>
<td>Yes +1</td>
</tr>
<tr>
<td>Migration of pain to RLQ</td>
<td>No 0</td>
<td>Yes +1</td>
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Discussion: Appendiceal Signs

• Most reliable signs in children:
  • Absent or decreased bowel sounds (LR+ = 3.1)
  • Psoas sign (LR+ = 3.2)
    • Pain on passive extension of right thigh
  • Obturator sign (LR+ = 3.5)
    • Pain on passive internal rotation of femur
  • Rovsing sign (LR+ = 3.5)
    • Palpation of LLQ causes pain in RLQ
Discussion: Prognosis

• Prognosis:
  • Unknown prognosis of untreated appendicitis (unethical)
    • Spontaneous resolution ranges 4% - 20%
    • “The grumbling appendix” recurrence risk

• Risk factors for perforation in children:
  • Fever, vomiting, longer duration of symptoms (delay in surgery > 48 hours), elevated CRP/WBC, ultrasound with free fluid, visualized perforation, mean appendix diameter > 11 mm"
Treatment

• **Laparoscopic appendectomy**
  - Current standard to prevent potential complications
  - Increasing evidence on use of antibiotics

• **Open vs laparoscopic appendectomy**
  - Laparoscopic with less wound infection (odds ratio: 0.43)
  - Laparoscopic with more intra-abdominal abscess formation (odds ratio: 1.87)\(^3\)

• **IV antibiotics vs appendectomy**
  - For patients with uncomplicated appendicitis 73% resolution rate
  - Ertapenem 1 g per day IV x3 days, levofloxacin 500 mg per day + metronidazole 500mg TID x7 days
  - Antibiotic treatment with decreased complications and need for pain medications
  - 40% with antibiotic therapy require appendectomy within 1 year\(^6\)
ACR Appropriateness Criteria - Pediatrics

- RLQ abdominal pain, fever, leukocytosis with suspected appendicitis, uncertain if ruptured
- US **appropriate** according to ACR appropriateness criteria

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<tr>
<td>Procedure</td>
<td>Appropriateness Category</td>
</tr>
<tr>
<td>US abdomen RLQ</td>
<td>Usually Appropriate</td>
</tr>
<tr>
<td>US abdomen</td>
<td>Usually Appropriate</td>
</tr>
<tr>
<td>CT abdomen and pelvis with IV contrast</td>
<td>May Be Appropriate (Disagreement)</td>
</tr>
<tr>
<td>CT abdomen and pelvis without IV contrast</td>
<td>May Be Appropriate (Disagreement)</td>
</tr>
<tr>
<td>MRI abdomen and pelvis without and with IV contrast</td>
<td>May Be Appropriate (Disagreement)</td>
</tr>
<tr>
<td>MRI abdomen and pelvis without IV contrast</td>
<td>May Be Appropriate (Disagreement)</td>
</tr>
<tr>
<td>Radiography abdomen</td>
<td>May Be Appropriate (Disagreement)</td>
</tr>
<tr>
<td>CT abdomen and pelvis without and with IV contrast</td>
<td>Usually Not Appropriate</td>
</tr>
<tr>
<td>US pelvis</td>
<td>Usually Not Appropriate</td>
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Imaging Cost

• US Abdomen Limited at Memorial Hermann-Texas Medical Center
  • Insured: total cost $1493, out-of-pocket $262
  • Uninsured: $537
Take Home Points

• Utilize the prediction scores and physical exam signs to stratify risk and help determine next steps

• Ultrasound is imaging of choice for children and pregnant patients

• Either appendectomy or antibiotics are viable options for uncomplicated appendicitis, but surgical management is necessary for complicated appendicitis
References

1) Acute appendicitis on ultrasound. Website URL: https://radiopaedia.org/cases/acute-appendicitis-on-ultrasound-1?lang=us
3) Appendicitis. Website URL: https://www.aafp.org/afp/2016/0115/p142.html
5) Pediatric Appendicitis Score (PAS). Website URL: https://www.mdcalc.com/pediatric-appendicitis-score-pas#evidence
7) ACR Appropriateness Criteria, Pediatrics Suspected Appendicitis. Website URL: https://acsearch.acr.org/docs/3105874/Narrative/
8) Cost of imaging at Memorial Hermann. Website URL: https://www.memorialhermann.org/patients-caregivers/pricing-estimates-and-information/
Questions?