Everyday Pediatric Surgery: What’s New?

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Alabama AAP
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Learning Objectives

- Understand new concepts in the management of children with perforated appendicitis
- Describe new minimal invasive surgical techniques for the care of common surgical problems
Perforated Appendicitis

- 320,000 appendectomy in children annually
- 25-30% are perforated at presentation
  - 80% or higher in children <3 years old
  - Mortality rate is 0.1-1%
    - 10-20% 50 years ago
  - Morbidity rate is 10-20%
    - Intra-abdominal abscess, sbo
Perforated Appendicitis

- Presentation
  - Symptoms > 48 hrs
    - Pain, N/V, fever, diarrhea
    - Difficult to determine in young children
Perforated Appendicitis

- Physical Exam
  - General state of health
  - Localized vs. diffuse tenderness
  - Abdominal distension
  - Palpable mass
Perforated Appendicitis

- Labs and diagnostic studies
  - WBC > 15K
  - US and/or CT
    - Sensitivity, specificity, accuracy comparable
Perforated Appendicitis

- CT
  - Easily accessible
  - Less operator dependent
  - Provides more thorough exam of abdomen
  - Increases cancer risk
Perforated Appendicitis

- Management
  - Survey of APSA members
    - 79% favor abx/interval appendectomy
    - 60-70% tended to use CT-guided drainage
    - 21% favor immediate appendectomy
Perforated Appendicitis

- Immediate appendectomy may be more complicated technically
- Tissue planes less clear due to inflammation, potential for bleeding and injury to adjacent organs
- Questionable benefit to immediate appendectomy
Perforated Appendicitis

- Initial laparoscopic appendectomy versus initial nonoperative management and interval appendectomy for perforated appendicitis with abscess: a prospective, randomized trial
- St. Peter SD, et al.; Kansas City
- Journal of Pediatric Surgery 2010
Initial Appendectomy vs. Abx/Interval Appendectomy

**Methods:**

- Children with well-defined abdominal abscess (CT)
- 2 year study with 40 patients accrued

Immediate lap appy

IV abx with perc drainage (when possible)
Followed by interval lap appy 10 weeks later
Initial Appendectomy vs. Abx/Interval Appendectomy

Methods:

Immediate appendectomy

5 days abx (ceftriaxone/metronidazole)

Fever/symptoms/leukocytosis → Afebrile, asymptomatic, nl WBC

2 days abx
Then repeat WBC

Fever/symptoms/leukocytosis → Discharged

3 days abx
Then repeat WBC
CT may be done after POD 7
Initial Appendectomy vs. Abx/Interval Appendectomy

Methods:

- IV abx with perc drainage (when possible)
- 2 weeks abx (ceftriaxone/metronidazole)
- Symptoms/pain/mass
- Afebrile, asymptomatic
- 1 week abx and reassess CT may be done
- D/C abx
- Interval appy at 10 weeks
### Table 1  Patient characteristics at the time of admission

<table>
<thead>
<tr>
<th></th>
<th>Initial operation (n = 20)</th>
<th>Initial nonoperative management (n = 20)</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>10.1 ± 4.2</td>
<td>8.8 ± 4.2</td>
<td>.31</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>37.0 ± 16.2</td>
<td>37.1 ± 20.8</td>
<td>.98</td>
</tr>
<tr>
<td>Body mass index (kg/cm²)</td>
<td>18.0 ± 4.5</td>
<td>19.5 ± 5.5</td>
<td>.39</td>
</tr>
<tr>
<td>White blood cell count</td>
<td>17.4 ± 6.6</td>
<td>16.9 ± 6.8</td>
<td>.84</td>
</tr>
<tr>
<td>Maximum temperature</td>
<td>37.8 ± 1.0</td>
<td>37.7 ± 0.9</td>
<td>.95</td>
</tr>
<tr>
<td>Maximum axial area of abscess (cm²)</td>
<td>29.2 ± 29.7</td>
<td>26.2 ± 21.1</td>
<td>.75</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± SD.
Initial Appendectomy vs. Abx/Interval Appendectomy

- Initial lap appendectomy group
  - 1 conversion to open due to fragmented appendix
  - 1 lap assisted ileocectomy for inflammatory mass
Initial Appendectomy vs. Abx/Interval Appendectomy

- Abx/interval appendectomy group
  - 14 had percutaneous drainage
  - 4 failed abx therapy and operated on prior to 10 weeks
    - 1 for progression of peritonitis (day 2)
    - 1 for persistent obstruction (day 6)
    - 1 for persistent symptoms (3 weeks)
    - 1 for persistent nausea and occasional emesis (7 weeks)
Table 2  Outcomes comparing initial operation and initial abscess drainage followed by interval appendectomy

<table>
<thead>
<tr>
<th></th>
<th>Initial operation (n = 20)</th>
<th>Initial nonoperative management (n = 20)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation time (min)</td>
<td>62.1 ± 38.7</td>
<td>42.0 ± 45.5</td>
<td>.06</td>
</tr>
<tr>
<td>Total length of hospitalization (d)</td>
<td>6.5 ± 3.8</td>
<td>6.7 ± 6.6</td>
<td>.92</td>
</tr>
<tr>
<td>Recurrent abscess after initial</td>
<td>20%</td>
<td>25%</td>
<td>1.0</td>
</tr>
<tr>
<td>treatment (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doses of narcotics</td>
<td>9.7 ± 4.0</td>
<td>7.1 ± 15.8</td>
<td>.47</td>
</tr>
<tr>
<td>Total health care visits</td>
<td>2.8 ± 1.1</td>
<td>4.1 ± 1.0</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>No. of CT scans</td>
<td>1.5 ± 0.7</td>
<td>2.1 ± 1.1</td>
<td>.04</td>
</tr>
<tr>
<td>Time to goal intake (h)*</td>
<td>74.8 ± 53.9</td>
<td>23.3 ± 36.9</td>
<td>.002</td>
</tr>
<tr>
<td>Total charges</td>
<td>$44,195 ± $19,384</td>
<td>$41,687 ± $18,483</td>
<td>.68</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± SD, unless otherwise indicated.

* Time to regular diet after drain placement or evaluation by interventional radiology in the initial nonoperative group.
Perforated Appendicitis

- Early vs Interval Appendectomy for Children with Perforated Appendicitis
  - Blakely ML, et al.; Memphis
  - Archive of Surgery, 2011

- Primary outcome: time away from normal activities
Early vs Interval Appendectomy

- Eligible: children with clinical diagnosis of perforated appendicitis
- Excluded: children initially treated at another hospital; delayed presentation with well-formed abscess or mass; family transient to the area or unable to complete follow-up
- Diagnosis made by history, exam, labs, and imaging results (116 of 131 had CT)
Early vs Interval Appendectomy

247 Assessed for eligibility

116 Excluded
73 ineligible
43 Refused

131 Randomized

64 Early appendectomy group
64 Received appendectomy
0 Lost to follow-up
64 Analyzed

67 Interval appendectomy group
65 Received appendectomy
0 Lost to follow-up
67 Analyzed
Early vs Interval Appendectomy

- Antibiotics and discharge criteria same for both groups
- Antibiotic regimen: ceftazidime and clindamycin
- Discharged when tolerating feeds, had good pain control, ambulating well, afebrile for 48 hours with normal WBC and differential
Early vs Interval Appendectomy

- **Primary outcome**: time away from normal activities
  - Assessed by objective and subjective criteria
    - Hospital days and outpatient IV abx day
    - Activity log; phone and clinic follow-up
    - Time to return to school
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Early (n=64)</th>
<th>Interval (n=67)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (range), y</td>
<td>10.5 (1.8-16.6)</td>
<td>9.9 (2.6-17.3)</td>
<td>.29</td>
</tr>
<tr>
<td>Male sex</td>
<td>40 (63)</td>
<td>33 (49)</td>
<td>.13</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td>.03</td>
</tr>
<tr>
<td>Black</td>
<td>39 (47)</td>
<td>28 (42)</td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>13 (20)</td>
<td>12 (18)</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>20 (31)</td>
<td>26 (39)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>1 (2)</td>
<td>1 (1)</td>
<td></td>
</tr>
<tr>
<td>Duration of symptoms, mean (range), d</td>
<td>3.4 (1-14)</td>
<td>3.4 (1-17)</td>
<td>.93</td>
</tr>
<tr>
<td>ED temperature, mean (range), °C</td>
<td>38.0 (36.2-30.8)</td>
<td>38.4 (36.2-40.2)</td>
<td>.01</td>
</tr>
<tr>
<td>Admission WBC count, mean (range), No. x 10⁹/l</td>
<td>17.6 (5.2-34.3)</td>
<td>16.8 (5.6-28.7)</td>
<td>.38</td>
</tr>
<tr>
<td>Abdominal CT performed at initial assessment</td>
<td>55 (87)</td>
<td>61 (91)</td>
<td>.49</td>
</tr>
<tr>
<td>IAA at admission</td>
<td>25 (39)</td>
<td>26 (39)</td>
<td>.98</td>
</tr>
<tr>
<td>ICU admission</td>
<td>2 (3)</td>
<td>3 (4)</td>
<td>&gt;.00</td>
</tr>
</tbody>
</table>
Early vs Interval Appendectomy

- Early appendectomy group (64 patients)
  - 55 lap appendectomy, 6 open
  - 3 lap converted to open
  - 7 did not have perforated appendicitis
    - 5 acute, 1 ileal volvulus, 1 primary peritonitis
Interval appendectomy group (67 patients)
- Average time to appendectomy was 51 days
- 60 lap; 3 open; 2 lap converted to open
  - 2 did not return for appendectomy
- 23 had appendectomy earlier than planned
  - 10 bowel obstruction, 5 persistent symptoms, 6 recurrent appendicitis, 1 unresolved abscess, 1 parental demand
- 1 did not have perforated appendicitis
Early vs Interval Appendectomy

- Primary outcome of time away from normal activities:
  
  13.8 vs 19.4 days, p < .001
Table 2. Health Care Use After Early Appendectomy or Interval Appendectomy

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Early (n=64)</th>
<th>Interval (n=67)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Received central venous catheter, No. (%)</td>
<td>28 (44)</td>
<td>58 (87)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Discharged with central venous catheter, No. (%)</td>
<td>6 (9)</td>
<td>29 (43)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Underwent IR procedure, No. (%)</td>
<td>13 (21)</td>
<td>15 (23)</td>
<td>.77</td>
</tr>
<tr>
<td>Total antibiotic duration, mean (range), d</td>
<td>13 (3-30)</td>
<td>15 (6-30)</td>
<td>.10</td>
</tr>
<tr>
<td>Operative time, mean (range), min</td>
<td>113 (39-213)</td>
<td>112 (48-295)</td>
<td>.95</td>
</tr>
<tr>
<td>CT scans during study period, mean (range), No.</td>
<td>1.3 (0-5)</td>
<td>1.7 (0-6)</td>
<td>.06</td>
</tr>
<tr>
<td>Hospital length of stay, mean (range), d</td>
<td>9 (2.6-23.9)</td>
<td>11.2 (3.3-40)</td>
<td>.03</td>
</tr>
<tr>
<td>Event</td>
<td>Early (n=56)</td>
<td>Interval (n=67)</td>
<td>RR Associated With Interval Appendectomy (95% CI)</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>--------------</td>
<td>----------------</td>
<td>---------------------------------------------------</td>
</tr>
<tr>
<td>Any adverse event</td>
<td>19 (30)</td>
<td>57 (55)</td>
<td>1.86 (1.21-2.87)</td>
</tr>
<tr>
<td>Intra-abdominal abscess</td>
<td>12 (19)</td>
<td>25 (37)</td>
<td>1.99 (1.10-3.22)</td>
</tr>
<tr>
<td>Small bowel obstruction</td>
<td>0</td>
<td>7 (10.4)</td>
<td></td>
</tr>
<tr>
<td>Wound infection</td>
<td>6 (9.4)</td>
<td>6 (9.0)</td>
<td>0.94 (0.32-2.75)</td>
</tr>
<tr>
<td>Unplanned readmission</td>
<td>5 (8)</td>
<td>21 (31)</td>
<td>3.94 (1.53-9.84)</td>
</tr>
<tr>
<td>CVL-related adverse event</td>
<td>1 (1.6)</td>
<td>4 (6.0)</td>
<td>0.88 (0.21-3.72)</td>
</tr>
<tr>
<td>IR procedure-related adverse event</td>
<td>0</td>
<td>1 (1.5)</td>
<td></td>
</tr>
<tr>
<td>Recurrent appendicitis</td>
<td>0</td>
<td>6 (9)</td>
<td></td>
</tr>
</tbody>
</table>
Early vs Interval Appendectomy

- **Discussion**
  - Design of study is not clean
    - No equipoise
    - Data unclear
  - High failure rate (34%)
    - Bowel obst, recurrent appendicitis, persistent symptoms
Pediatric versus general surgeon

- Specialty versus generalist care of children with appendicitis: an outcome comparison
- Alexander F, et al; Cleveland, OH
- Journal of Pediatric Surgery
Pediatric versus general surgeon

- Academic center with 2 services
  - Pediatric Surgical Service
  - HMO Adult General Surgical Service
- Identical anesthesia, residents, nursing, and ancillary support services
<table>
<thead>
<tr>
<th>Pediatric Surgical Service</th>
<th>HMO Adult General Surgical Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>34 patients</td>
<td>27 patients</td>
</tr>
<tr>
<td>Complications 3</td>
<td>Complications 9</td>
</tr>
<tr>
<td>Readmissions 0</td>
<td>Readmissions 6</td>
</tr>
<tr>
<td>Second operation 2</td>
<td>Second operation 6</td>
</tr>
<tr>
<td>LOS 5.4</td>
<td>LOS 8.6</td>
</tr>
</tbody>
</table>
Failure in the nonoperative management

- UAB/Children’s study
- Retrospective review of 75 children over 4 years who were treated with abx and intent for interval appendectomy
Failure in the nonoperative management

- 9/75 failed nonoperative management
- 7 for persistent significant pain
- Absence of abscess and presence of appendicolith were predictors of failure
Our Protocol

- Clinical diagnosis and confirmed by imaging
  - Phlegmon/abscess
- Initiate abx (piperacillin/tazobactam)
- Place PICC
- Percutaneously drain abscess if possible
- Start PO when ready and home abx when possible
- 10-14 day course with follow-up in clinic
- Interval appendectomy at 6-8 weeks
SIPES Appendectomy - Our Data

- Prospectively enrolled/collected
- Two year period (March 2009 - May 2011)
  - 328 appendectomies performed
  - 60 perforated (18%)
  - 310 SIPES (95%)
  - Median Op times 37.4 +/- 13.8 minutes
**SIPES Cholecystectomy**

- Early experience showed technically feasible and safe
  - Over 90 patients
- No increased complications
SIPES

- Ablative surgery easier than restorative but not prohibitive
- Splenectomy (12)
- Nissen Fundoplication (10)
- Bowel resection, colectomy, pyloromyotomy
- Still evolving-surgeon and technology