Current Management of Children with Appendicitis

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Kansas City, Missouri
Three Presentations

- Acute appendicitis (non-perforated) 60 - 65%
- Perforated appendicitis 25 - 30%
- Perforated appendicitis with well-defined abscess (5-7 day history) 5 - 10%
Acute Appendicitis (No Perforation)

- April 2003 – Nov 2006
- 609 Pts – laparoscopic appendectomy
- 3 post-op abscesses (0.49%)
Acute Appendicitis

Appendiceal Perforation

- Perforated appendicitis (3 - 5 day hx)
  - Evacuation of purulent material
  - Wound problems minimized with laparoscopic approach
  - 20% post-op abscess rate
Contemporary Questions

1. Do we need to operate?
2. Do we need to operate in the middle of the night?
3. Is there an optimal antibiotic regimen for perforated appendicitis?
4. How do we define perforated appendicitis?
5. How do we manage the patient presenting with an abscess?
6. Do we need to irrigate for perforated appendicitis?
7. Which is better: SSULS or 3 port appendectomy?
8. Is there a cosmetic advantage to performing a laparoscopic appendectomy through a single umbilical incision?
1. Do We Need to Operate?

**Adult Studies**


Summary

• Non-operative management with antibiotics for both acute and perforated appendicitis in adults is successful as primary, definitive therapy in up to 70% of patients.

• About 30% of adults will fail antibiotic management and will need an operation.
1. Do We Need to Operate?

Pediatric Studies

Feasibility of a Nonoperative Management Strategy for Uncomplicated Acute Appendicitis in Children

Peter C Minneci, MD, MHSc, FACS, Jason P Sulkowski, MD, Kristine M Nacion, MPH, Justin B Mahida, MD, Jennifer N Cooper, PhD, MS, R Lawrence Moss, MD, FACS, Katherine J Deans, MD, MHSc, FACS

BACKGROUND: For decades, urgent operation has been considered the only appropriate management of acute appendicitis in children. The purpose of this study was to investigate the feasibility of nonoperative management of uncomplicated acute appendicitis in children.

STUDY DESIGN: A prospective nonrandomized clinical trial of children with uncomplicated acute appendicitis comparing nonoperative management with urgent appendectomy was performed. The primary result was 30-day success rate of nonoperative management. Secondary outcomes included comparisons of disability days, missed school days, hospital length of stay, and measures of quality of life and health care satisfaction.

RESULTS: Seventy-seven patients were enrolled during October 2012 to October 2013; 30 chose nonoperative management and 47 chose surgery. There were no significant differences in demographic or clinical characteristics. The immediate and 30-day success rates of nonoperative
Study Details

- Pilot study
- Non-perforated appendicitis
- Families chose therapy; not randomized
- F/U – 1 month
- 77 pts – Oct 2012 - 2013
  - 47 chose operation
  - 30 chose non-op mgmt
    - Immediate success – 93%
    - 30 day success – 90%
1. Do We Need to Operate?

Pediatric Studies

Randomized Controlled Trial

Nonoperative Treatment With Antibiotics Versus Surgery for Acute Nonperforated Appendicitis in Children

A Pilot Randomized Controlled Trial

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Objective: The aim of this study was to evaluate the feasibility and safety of nonoperative treatment of acute nonperforated appendicitis with antibiotics in children.

Methods: A pilot randomized controlled trial was performed comparing nonoperative treatment with antibiotics versus surgery for acute appendicitis in children. Patients with imaging-confirmed acute nonperforated appendicitis who would normally have had emergency appendectomy were randomized either to treatment with antibiotics or to surgery. Follow-up was for 1 year.

treatment of acute appendicitis has been appendectomy. However, there is growing interest in nonoperative treatment of acute nonperforated appendicitis with antibiotics. Several randomized controlled trials (RCTs) have been performed in adults and these have also been subjected to meta-analysis. Data suggest that antibiotic treatment may be an effective treatment modality for adults with acute nonperforated appendicitis and that approximately 75% of patients may not need appendectomy at all, either during initial illness or during the first year of follow-up.1 However, a recent Cochrane review concluded that
Study Details

- Pilot, randomized control trial (1 yr f/u)
- 50 pts –
  - 26 operation → all + appendicitis
  - 24 non-op mgmt
    - 2 pts failed early
    - 1 pt recurred 9 months
    - Another 6 underwent operation for recurrent abd pain
  - 38% underwent operation
1. Do We Need to Operate?

Pediatric Studies

**Online First**

**Early vs Interval Appendectomy for Children With Perforated Appendicitis**

Martin L. Blakely, MD, MS; Regan Williams, MD; Melvin S. Dassinger, MD; James W. Eubanks III, MD; Peter Fischer, MD, MS; Eunice Y. Huang, MD, MS; Elizabeth Paton, PNP; Barbara Culbreath, BSN, CCRC; Allison Hester, PNP; Christian Streel, MD; S. Douglas Hixson, MD; Max R. Langham Jr, MD

**Objective:** To compare the effectiveness and adverse event rates of early vs interval appendectomy in children with perforated appendicitis.

**Design:** Nonblinded randomized trial.

**Setting:** A tertiary-referral urban children’s hospital.

**Patients:** A total of 131 patients younger than 18 years

**Results:** Early appendectomy, compared with interval appendectomy, significantly reduced the time away from normal activities (mean, 13.8 vs 19.4 days; *P < .001*). The overall adverse event rate was 30% for early appendectomy vs 55% for interval appendectomy (relative risk with interval appendectomy, 1.86; 95% confidence interval, 1.21-2.87; *P = .003*). Of the patients randomized to interval appendectomy, 23 (34%) had an appendectomy earlier than planned owing to failure to improve (*n = 17*), recurrent appendicitis (*n = 5*), or other reasons (*n = 1*).
Study Details

• 131 children, randomized study
• **Perforated** appendicitis
• Early appendectomy (w/in 24 hrs admission) vs initial non-operative mgmt followed by interval appendectomy (6-8 weeks later)
• 1º outcome variable – time away from normal activities (days)
  • (13.8 d vs 19.4 d, p < 0.001 – favoring operation)
• 23/67 (34%) randomized to non-operative mgmt. underwent appendectomy earlier than planned (17 – failure to improve, 5 – recurrent appendicitis) – 66% successful non-op mgmt
Non-Operative Management Summary

• Non-operative management of appendicitis is a hot topic

• Several definitive randomized trials will be forthcoming

• What will be threshold for failure of non-operative management?
2. When to Operate?
Current Practice at CMH

- Patients identified with appendicitis are booked for laparoscopic appendectomy
  - All receive a dose of Ceftriaxone (Rocephin) (50mg/kg) and Metronidazole (Flagyl) (30mg/kg)
  - This antibiotic regimen was shown to be most cost effective in PRT
  - If patients present at night, the operations are scheduled for the ‘surgeon of the week’ the next day
  - Appendectomies rarely occur after 10 PM at night

- Retrospective comparison in children (Level 3 study) between operation < 6 hrs after presentation or the following day
  - 126 patients (38 early vs 88 late)
  - No differences in operating time, perforation rate, or complications
3. How Do We Define Perforated Appendicitis?

- The literature is replete with retrospective studies regarding perforated appendicitis.
- All of these studies fail to strictly define perforation.
  - Dependent on surgeon’s definition.
  - “Gangrenous”, “suppurative”, “perforated”.
- Therefore, the conclusions from these retrospective reports must be approached cautiously.
An evidence-based definition for perforated appendicitis derived from a prospective randomized trial

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Key words:
Definition
Perforation
Appendicitis
Children

Abstract
Purpose: Appendicitis is the most common urgent condition in general surgery, and yet there is no evidence-based definition for perforation. Therefore, all retrospective data published on perforated appendicitis are unreliable because of an ill-defined denominator. For approximately 2 years beginning in April 2005, we performed a prospective randomized trial investigating 2 different antibiotic regimens for perforated appendicitis. During this study, we strictly defined perforation as a hole in the appendix or a fecalith in the abdomen. Before this prospective study, perforation was staff surgeon opinion. We investigated the abscess rates in both the perforated and nonperforated appendicitis populations before and during the study to determine if our definition was safe and that there was not an increased risk of abscess formation in patients treated as nonperforated.

Methods: Records of all patients undergoing laparoscopic appendectomy for appendicitis during the immediate 2 years before using the definition were compared to those treated in the 2 years after the
Definition of Perforation Used in Prospective Randomized Trial

Hole in appendix

Visible appendicolith
4. How do we manage the child presenting with an abscess due to perforated appendicitis?
Perforated Appendicitis Presenting With Abscess

History - 2000

• Open operation for abscess is difficult
• Percutaneous drainage had been described and applied
• Laparoscopy was being used to treat perforated appendicitis and abscess
• Which is better?
Abscess Study

Prospective Randomized Trial

- Drainable abscess
- Laparoscopic appendectomy vs percutaneous drainage as initial management
- Drain groups undergoes laparoscopic interval appendectomy at 10 weeks.
- Quality of life surveys at admission, at 2 weeks, and at 12 weeks
- Pilot study – 40 patients

APSA 2009

## Initial Non-Op Mgmt vs Lap Appendectomy in Children Presenting with an Abscess

**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/cm(^2))</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 (cm(^2))</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

**APSA 2009**
**J Pediatr Surg 45:236-240, 2010**
## Initial Non-Op Mgmt vs Lap Appendectomy in Children Presenting with an Abscess

<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 treatment (%)</td>
<td>20%</td>
<td>25%</td>
<td>1.0</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>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.
Prospective Randomized Trial

• Conclusion – There is no difference b/w initial laparoscopic operation vs initial non-operative management followed by laparoscopic interval appendectomy

• Management can be determined by the surgeon’s preference and experience

APSA 2009
5. Is there an advantage to performing the laparoscopic appendectomy through a single umbilical incision?
SSULS Appendectomy
Prospective Randomized Trial

Single Umbilical Incision vs 3-Port Laparoscopic Appendectomy

- 360 total patients
- Acute non-perforated appendicitis
- August 09 – November 10
- Primary outcome variable – postoperative wound infection
- Standardized pre and postoperative management
- Quality of life surveys at 6 weeks and 6 months

ASA 2011
### Patient Characteristics at Operation

<table>
<thead>
<tr>
<th></th>
<th>Single Incision (N=180)</th>
<th>3-Port (N=180)</th>
<th>(P)-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>11.05 ± 3.47</td>
<td>11.04 ± 3.41</td>
<td>0.98</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>42.7 ± 18.5</td>
<td>42.5 ± 17.4</td>
<td>0.90</td>
</tr>
<tr>
<td>Gender (% male)</td>
<td>54.4%</td>
<td>51.1%</td>
<td>0.53</td>
</tr>
<tr>
<td>Leukocyte count</td>
<td>14.7 ± 5.2</td>
<td>14.6 ± 5.4</td>
<td>0.89</td>
</tr>
</tbody>
</table>

ASA 2011
## Outcome Data

<table>
<thead>
<tr>
<th></th>
<th>Single Incision (N=180)</th>
<th>3-Port (N=180)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wound Infection</strong></td>
<td>3.3%</td>
<td>1.7%</td>
<td>0.50</td>
</tr>
<tr>
<td><strong>Operative Time (mins)</strong></td>
<td>35.2 ± 14.5</td>
<td>29.8 ± 11.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Postoperative Length of Stay (hours)</strong></td>
<td>22.7 ± 6.2</td>
<td>22.2 ± 6.8</td>
<td>0.44</td>
</tr>
<tr>
<td><strong>Hospital Charges ($)</strong></td>
<td>17.6K ± 4.0K</td>
<td>16.5 ± 3.8K</td>
<td>0.005</td>
</tr>
</tbody>
</table>

ASA 2011
6. Is there a cosmetic advantage to performing the laparoscopic appendectomy through a single umbilical incision?
Postoperative Appearance

SSULS

3 - Port
Patient and parental scar assessment after single incision versus standard 3-port laparoscopic appendectomy: Long-term follow-up from a prospective randomized trial

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Laparoscopy
Appendectomy

ABSTRACT

Background: Single site laparoscopy for appendectomy is a technique with several case series suggesting a cosmetic advantage, but without prospective comparative data. We conducted a prospective, randomized trial comparing single site laparoscopic appendectomy to the standard 3-port approach, including scar assessment at early and long-term follow-up.

Methods: Enrolled patients over 12 years old and parents of patients less than 12 years old were asked to complete the validated Patient Scar Assessment Questionnaire (PSAQ) at early follow-up around 6 weeks and by phone after 18 months. The PSAQ consists of 4 scored subscales: Appearance, Consciousness, Appearance Satisfaction, and Parental Satisfaction. Each subscale has a set of questions with a 4-point categorical
Methods

- Patients enrolled in the trial completed the PSAQ (Patient Scar Assessment Questionnaire)
- Survey was obtained from:
  - Patients 12 years or older
  - Parents of patients less than 12 years old
  - PSAQ completed in early and late follow up
    - Early - 6 weeks post-op clinic visit
    - Late - after at least 18 months post-op by phone call
    - Contacting physicians were blinded to patient data/study results

APSA 2013
## Results

### PSAQ Scores: Early Follow Up (6 weeks)

<table>
<thead>
<tr>
<th></th>
<th>Best Possible Score</th>
<th>3 Port Appendectomy (N=98)</th>
<th>Single site Appendectomy (N=100)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>9</td>
<td>15.34 ± 3.77</td>
<td>13.46 ± 3.24</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Consciousness</td>
<td>6</td>
<td>9.27 ± 2.35</td>
<td>8.59 ± 2.42</td>
<td>0.01</td>
</tr>
<tr>
<td>Satisfaction with Appearance</td>
<td>8</td>
<td>11.78 ± 3.80</td>
<td>10.77 ± 3.72</td>
<td>0.03</td>
</tr>
<tr>
<td>Satisfaction with Symptoms</td>
<td>5</td>
<td>6.70 ± 2.46</td>
<td>6.25 ± 2.05</td>
<td>0.17</td>
</tr>
<tr>
<td>TOTAL</td>
<td>28</td>
<td>43.08 ± 9.20</td>
<td>39.07 ± 9.23</td>
<td>0.001</td>
</tr>
</tbody>
</table>

**APSA 2013**

# Results

## PSAQ Scores: Late Follow Up (18-32 months)

<table>
<thead>
<tr>
<th></th>
<th>Best Possible Score</th>
<th>3 Port Appendectomy (N=49)</th>
<th>Single site Appendectomy (N=56)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>9</td>
<td>10.39 ± 2.03</td>
<td>9.64 ± 1.29</td>
<td>0.05</td>
</tr>
<tr>
<td><strong>Consciousness</strong></td>
<td>6</td>
<td>6.41 ± 1.08</td>
<td>6.29 ± 0.85</td>
<td>0.58</td>
</tr>
<tr>
<td><strong>Satisfaction with</strong></td>
<td><strong>Appearance</strong></td>
<td>8</td>
<td>8.08 ± 0.34</td>
<td>0.96</td>
</tr>
<tr>
<td><strong>Satisfaction with</strong></td>
<td><strong>Symptoms</strong></td>
<td>5</td>
<td>5.00 ± 0.00</td>
<td>0.87</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>28</td>
<td>29.86 ± 2.97</td>
<td>29.12 ± 2.37</td>
<td>0.06</td>
</tr>
</tbody>
</table>

**APSA 2013**

*J Pediatr Surg 49: 120–122, 2014*
Conclusions

- The short-term results demonstrate significantly more favorable perception of scar scores with the single-incision approach.

- At two years, these differences largely vanish.

- Long term follow up responses approach best possible scores in both groups.

- Our group now utilizes the single site approach in non-overweight/obese children with non-perforated appendicitis, and we have a low threshold for additional ports if needed.

APSA 2013
What’s New Now?

• Non-perforated patients being discharged w/in 6 hours of operation – same day as operation

• Our group is now participating in a multi-institutional, multi-national study comparing non-operative vs operative treatment for non-perforated appendicitis
APPY Trial:
Collaborating Centres

• Canada
  • Vancouver, Calgary, Winnipeg, Ottawa, Hamilton, London, Montreal, Toronto

• USA
  • Kansas City, Memphis

• Europe
  • Stockholm, Helsinki, Toulouse, Rennes
APPY Trial: Sample Size

• Non-inferiority margin of 20%

• 880 children (2 equal groups of 440)

• 10% drop out and loss to follow-up: 978 (2 equal groups of 489)
CMH Early Results

• 51 Enrolled
  • 27 OR –
    • 4 found perfed
    • 2 negative path
    • 1 readmit (abscess)

• 24 Non Op
  • 3 failed early (1 perf)
  • 4 failed after d/c (2-5 days for 3, 6 mos in one)
  • All with appendicitis on path