Appendicitis

Controversies and Problems in Surgery

December 20, 2013

Controversies

- Types and Use of Imaging Modalities
- Management in Adults, Children, Pregnancy
- Lap vs Open
- Management of Appendiceal Mass and Need for Interval Appendectomy
- Antibiotics vs. Appendectomy

Anatomy

- Vestigial Organ
- Base is attached to cecum
- Length variable
- Tip in any direction
- Cecum Moves in pregnancy and may be in abnormal location in children
- T and B Lymphoid Cells present

Pathophysiology

- Obstruction of the Lumen
  - Lymphoid hyperplasia
  - Benign or malignant tumors
  - Fecalith
  - Undigested food
- Increased Pressure
- Visceral Efferent Fibers T8-10
- Vascular Compromise
- Bacterial Overgrowth and Translocation
- Gangrenous Changes
  - 20 % in < 24 hours
  - 65 % who perf had sx > 48 hours

Epidemiology

- One of the most common causes of the acute abdomen, 233/100,000 population
- Most common condition in children requiring emergency abdominal surgery
- Most common general surgical condition encountered in Pregnancy
- Occurs most commonly in 2nd and 3rd decades of life
- Highest in 10-19 year old
- Male:Female 1.4:1
- Lifetime Risk
  - Male 8.6%
  - Female 6.7 %

Diff Diagnosis in Adults

- GI- Meckel's, Cecal Diverticulitis, Acute Ileitis, IBD, Perforated Cancer
- GYN- TOA, Rupture Ovarian Cyst, Torsion, Ectopic, PID, Mittleschmerz, Endometriosis, Endometritis
- GU- Testicular Torsion, Prostatitis, Renal Colic, Epididymitis, Torsion of appendix testis or appendix epididymis

Differential Diagnosis in Children

- Malrotation
- Intussusception
- Torsion of the Ovary or Omentum
- Hemolytic Uremic Syndrome
- Sickle Cell Disease
- Henoch-Schonlein Purpura
- Streptococcal Pharyngitis
- DKA

Imaging

- Use has increased dramatically
- Goal is to decrease Nontherapeutic Appendectomy Rate (NAR)
- Decrease incidence of perforation (delay)

CAT Scan

- Unenhanced CT
  - No Contrast
  - Fastest
  - Not good for alternate dx or planning
- Appendiceal CT Focused with Rectal Contrast
  - Next fastest
  - Less contrast given
  - Need someone to give contrast
- Standard CT with Oral and Intravenous Contrast
  - Takes the longest and exposes to contrast
  - Gold Standard for accuracy, making alternate diagnosis and planning for phlegmon or abscess

CT Findings

- Dilated Appendix > 6mm
- Thickened > 2mm
- Enhancing Wall
- Periappendiceal Fat Stranding
- Appendicolith (25 %)

Ultrasound

- Accurate
- No radiation
- No Contrast
- Quick
- Limited by Habitus
- Less useful for alternate diagnosis
- Technical and Interpreter Variability
- Availability

Ultrasound Findings

- Dilated > 7mm- most accurate
  - 6-7 mm considered inconclusive
- Noncompressible with wall thickeness > 2mm
- Local tenderness with compression
- Thickening of the mesentery
- Fluid in the pelvis
- Calcified appendicolith
- Must see the normal appendix to exclude appendicitis!

MRI

- No radiation
- Findings similar to CT but will not see appendiceal enhancement without Gad
- ? Delay
- ? Availability

Accuracy of Modalities in Adults Ultrasound vs CAT Scan vs Clinical

- Prospective Study 2763 Patients:
- Sensitivity, Specificity, PPV, NPV
  - Ultrasound 99.1, 91.7, 96.5, 97.7 percent
  - CAT Scan 96.4, 95.4, 95.6, 96.3 percent
  - Clinical Examination 99.0, 76.1, 88.1, 97.6 percent
    - Park et al Am Surg 2013
  - MRI 96.49, 94.8, 84.2, 94.1 percent
    - Inci et al Eur J Radiol 2011

Impact of Imaging-Adults

- Use of Imaging has increased from 32% (1995-1999) to 95% (2001-2008)
  - Wagner et al Surg 2008
- Retrospective Review- CT changed the treatment plan in 58% of patients
  - Schuler et al Arch Surg 1998

Impact of CT -Adults

Results are mixed

- Regarding NAR
  - Several studies failed to show decrease in NAR despite increased use of CT over time
  - Another shows NAR reduced to <10%
    - Cushieri et al Ann Surg 2008
- Regarding Perforation
  - Observed perf rate 9% in patients who underwent routine CT vs 25% in whom CT not used
    - Jones et al Am J Surg 2004
  - Other studies- No change in perforation rate over time despite increased use of CT

Value of CAT Scan in Adult Women

- Based on retrospective reviews adult women are twice as likely as men to have nontherapeutic appendectomy
- Retrospective review of 1425 consecutive patients adult women evaluated with preop CT had lower NAR rate compared with women who did not have CT- 8 versus 21 percent
    - Wagner et al Surgery 2008

Management- Adults Imaging

- Surgery with no imaging
  - Experienced observer
  - Young men with straightforward presentation
  - Probably should discuss with patient/family
- Imaging first
  - Diagnosis is unclear
  - Adult Women
  - Comorbidities
  - Elderly
  - Pregnancy
  - Mass
- Which Image- Conventional CAT Scan with Oral and Intravenous Contrast

Management Adults Uncomplicated Appendicitis Antibiotics Alone

- 243 Patients- Randomized Unasyn vs Appendectomy-
  - 12% required appendectomy within 30 days
  - 25% underwent appendectomy within one year (26 of 30 for acute appendicitis)
    - Vons et al The Lancet 2011
- Meta-analysis 350 patients treated with Antibiotics
  - 132 (32%) failed
  - Of 238 who responded 38(16%) recurred within one year
  - Overall 58 % of initial cohort remained aymptomatic at one year
    - Varadhan et al World J Surg 2010

Uncomplicated Appendicitis Antibiotics Alone

- Cochrane Review- 5 RCT's (901 patients)
- Studies were considered low to moderate quality
- In total 73.4% treated with antibiotics and 95% treated with appendectomy were cured within 2 weeks
- On a non inferiority analysis results were inconclusive
- Therefore Appendectomy still the gold standard

Antibiotics vs Appendectomy Summary

- 70-90% will improve with antibiotics
- 16-25 % will recur
- Appendectomy for uncomplicated appendicitis is of low morbidity
- Most authorities recommend Appendectomy for uncomplicated appendicitis
- Consider use in certain circumstances
- Few if any will perforate while under treatment

Acute Appendicitis
? Spontaneous Resolution

- RCT 104 women randomized to early laparoscopy vs. wait and watch for NSAP
  - Incidence of appendicitis 30% in LAP group
  - Incidence of appendicitis in OBS group 6%
    - Morino et al Ann Surg 2006

Laparoscopic vs. Open

- Cochrane Database- 6000 patients adults and children
- Meta-analysis 56 RCT's and 11 Non RCT's
  - (no difference between adults and children)
- Advantages for Lap
  - Lower rate of wound infections
  - Less pain of post op day 1
  - Shorter duration of hospital stay
- Disadvantages for Lap
  - Higher rate of intraabdominal abscess
  - Longer Operative Time
  - Higher operative and in-hospital cost
    - Sauerland et al Cochrane Database Syst Rev 2010

Laparoscopy over Open

- Uncertain diagnosis
- Obese patients
- Elderly patients
- Surgeon’s Comfort

The Appendiceal Mass

- Pathologically ranges from phlegmon to abscess
- Diagnosed in 2-6% of patients with appendicitis

Appendiceal Mass Approaches

- Immediate Appendectomy
- Conservative Therapy followed by Interval Appendectomy
  - Broad spectrum Antibiotics
  - Bowel Rest and Hydration
  - Drainage of Abscess
- Entirely Conservative approach without any appendectomy

Appendiceal Mass Immediate Surgery vs. Conservative Approach

- Meta-analysis – 16 Non Randomized Retrospective and 1 Non Randomized Prospective- 1,572 patients
- Conservative treatment associated with:
  - Overall less complications
  - Less ileus and bowel obstruction
  - Less intraabdominal abscess
- Conservative treatment NOT associated with:
  - Shorter initial or overall hospital stay
  - Duration of Antibiotics
    - Constantinos et al Surgery 2010

Currently the majority of surgeons favor the initial non operative management

Million Dollar Question is what to do next after successful conservative management of Appendiceal mass

Arguments FOR Interval Appendectomy

- Incidence of recurrent appendicitis is high
- Diagnose occult IBD
- Diagnose occult Malignancy masquerading as a phlegmon or appendiceal mass

Arguments Against Interval Appendectomy

- Incidence of recurrence is low
- Incidence of malignancy is low
- Morbidity of surgery is not insignificant
- Depending on timing of surgery would not prevent many recurrences

Interval Appendectomy Good

- Retrospective review of pathology on 46 interval appendectomies
  - 44% showed acute appendicitis
  - 15% showed chronic appendicitis
  - 4% Inflammatory bowel disease
  - 4% Mucinous cystadenoma

  - Lugo et al. J. Surg Research 2010

Interval Appendectomy Good

- Low Perioperative Morbidity
  - Complication Rate of 10% LOS 1.4 days
    - Yamini et al. A Surg. 1998

Appendectomy Evil

- Prospectively followed 94 patients (mean age 46 years) for three years after treatment of appendiceal mass
  - Recurrence rate 14.6%
  - Majority recurred in first 6 months
    - Tekin et al. Colorectal Dis. 2008

Appendectomy Evil

- Retrospective study 165 patients (mean age 53 years) treated conservatively for appendiceal mass
  - Recurrence rate 25%
  - 83 % in first 6 months
  - If appendectomy had been performed at 6 or 12 weeks only 16% and 10% would have been prevented
  - Overall appendectomy benefitted only 20% of patients
    - Lai et al. World J Surg. 2006

Appendectomy Evil

- Prospective non randomized study 51 patients followed after successful initial management
  - Recurrence rate 17.6%
  - 44% recurred within 6 weeks
  - 22% recurred between 6-12 weeks
  - 33% recurred after 12 weeks
  - One year recurrence rate 1.9%
  - Interval appendectomy at 6 or 12 weeks would have prevented 10% and 6% of recurrent appendicitis
    - Youssef et al Egyptian J Sur. 2010

Appendectomy Evil

- 233 Interval Appendectomies
  - 30% showed normal appendix without signs of inflammation
  - Complication rate 18%
    - Willemsen et al Dig Surg 2002
- 1012 Patients- No interval Appendectomy performed in 864 (85%)
  - Recurrence rate 5% (mean follow-up 4 years)
    - Kaminski et al. Arch Surg 2005

Spector of Malignancy Case

- 65 year old male had CT as part of evaluation of prostate cancer
- CT showed appendiceal mass
- Preop evaluation revealed that patient had had percutaneous drainage of appendiceal abscess two years prior
- At surgery found to have peritoneal carcinomatosis

Specter of Malignancy

- Of 70 interval appendectomies and 20 for recurrent appendicitis
  - 2% neoplastic changes
  - 3% colon cancers
    - Lai et al. World J Surg 2006
- Single Institution Study 18 interval appendectomies
  - 5 neoplasms (28%)
  - 3/5 were adenocarcinomas
    - Carpenter et al Am Surg 2012

Interval Appendectomy Summary

- Incidence of recurrent appendicitis is 5-25%
- Most recurrences occur in first 6 months
- Interval appendectomy performed at 6 or 12 weeks would miss most of the recurrences
- Therefore 89% and 93% of patients would have unnecessary appendectomies
- Morbidity is around 10%
- Risk of Malignancy is low 3-8%

Suggestions for Management

- In younger adults
  - Case by case basis
  - Is an appendicolith present?
- In older adults
  - Probably not justified simply to prevent recurrent appendicitis
  - Does low rate of malignancy justify interval appendectomy?
    - Yes if appendix highly abnormal without resolution
  - If not planning interval appendectomy must:
    - Update colonoscopy
    - Document resolution of appendiceal abnormality with imaging- and even then there may be risk of neoplasm
    - If abnormality persists be prepared to do more at the time of surgery

Appendicitis in Pregnancy

- Most common general surgical problem encountered during pregnancy
- Suspected 1/600-1/1000 and confirmed in 1/800-1/1500 pregnancies
- Pregnant women are less likely to have classic presentation
  - Enlargement of gravid uterus
  - Enlarged uterus stretches abdominal wall away from inflamed appendix
  - Physiologic leukocytosis during pregnancy

Appendicitis in Pregnancy Differential Diagnosis

- Ectopic Pregnancy
- Round ligament syndrome
- Pyelonephritis
- Abruptio Placenta and Uterine Rupture
- Post Partum
  - Endometritis
  - Ovarian Vein Thrombophlebitis or Septic Pelvic Thrombophlebitis

Imaging in Pregnancy Ultrasound

- Same findings as normal ultrasound
- Limited by-
  - Inability to do graded compression
  - Visibility limited by gravid uterus-especially in 3rd trimester
  - Experience of technician and radiologist
- Non visualization of appendix is more common
- Overall (with wide variation) sensitivity and specificity of ultrasound is decreased from in the non pregnant patient
  - Williams et al Emerg Med J 2007

Imaging in Pregnancy
MRI

- Offers attractive alternative to CT when clinical and ultrasound findings are inconclusive
- Gadolinium not routinely administered
- ACR Appropriateness Criteria
  - Suggests use of MRI as preferred test after inconclusive ultrasound
- Availability may be Limited

Imaging in Pregnancy
MRI- Results

- Meta-analysis of six studies 12-148 patients
- Pooled sensitivity 91% (95% CI 54-99)
- Pooled specificity 98% (95% CI 87-99)
  - Pedrosa et al Radiology 2009

Imaging in Pregnancy
CT

- Considered when Ultrasound not diagnostic and MRI not available
- Can modify protocol where fetal radiation exposure is estimated < 3mGy
  - Radiation exposure with normal CT 20-40mGy
  - Radiation exposure known to cause risk 30-50mGy
- Study of 81 pregnant patients NAR
  - Clinical exam only- 7/13- 54%
  - Clinical and Ultrasound- 20/55- 36%
  - Clinical, Ultrasound and CT- 1/13- 8%
    - Wallace et al J Gastrointest Surg 2008

Appendicitis in Pregnancy Morbidity

- Maternal morbidity following appendectomy is comparable to that in non pregnant women but higher in perforated vs. non perforated
- Risk of fetal loss and early delivery is increased with perforation
  - 36% vs. 1.5% fetal loss with perforation
    - Babaknia et al Obstet Gynecol 1977
  - 6% vs. 2% fetal loss with perforation
  - 11 % vs. 4% early delivery with perforation
    - McGory J Am Coll Surg 2007

Appendicitis in Pregnancy Management

- Primary management is prompt surgery
- Management with antibiotics alone not recommended
- Given difficulties with diagnosis and fetal risks with perforation a higher NAR is accepted
- There is no information regarding managing the appendicial mass or abscess

Appendicitis in Pregnancy Laparoscopy

- Numerous case reports and small series suggest lap appy can be performed successfully during all trimesters
- Not limited by location of incision
- Two meta-analyses suggest higher fetal loss
  - Walsh et al Int J Surg 2008
  - Wilasrusmee et al Br J Surg 2012
- Suggestions for laparoscopy
  - Open or LUQ initial access
  - Lower pneumoperitoneum pressures
  - Left side down positioning

Appendicitis in Children

- Most common condition in children to require emergency abdominal surgery
- Older children present more like adults
- Younger children can be difficult
  - Signs and symptoms may be nonspecific
  - Symptoms may not be adequately expressed
  - Apprehension and discomfort create challenge
- Imaging may play a greater role

Appendicitis in Children Epidemiology

- Uncommon in infants and preschoolers
- Increases with low from birth and four years to adolescence
- Boys slightly > girls
- Most frequent in second decade of life
- Advanced disease in children < 6 years old.
  - Perforation rates
    - Neonates 83%
    - Young children (< 5 years) 51-84%
    - School Age (5 to 12 years) 11-32%
    - Adolescents (>12) years 10-20%

Diagnostic Imaging in Children Ultrasound

- Meta-analysis of 26 studies- 9356 children
  - Pooled sensitivity 88%
  - Pooled specificity 94%
    - Dora et al. Radiology 2006
- Appendicitis cannot be excluded unless a normal appendix is seen
- Accuracy may vary with habitus, experience, technique, and length of symptoms
- When appendix is visualized diagnostic accuracy of US is equivalent to CT

Diagnostic Imaging in Children
CT

- Preferred imaging modality when ultrasound findings are equivocal
- Meta-analysis of 26 studies 9356 children
  - Pooled Sensitivity 94%
  - Pooled Specificity 95%
    - Doria et al Radiology 2006
- Variations
  - Contrast-Rectal, Oral, Intravenous
  - Focused CT
  - Technique
- Pitfalls of CT in children
  - Less fat- inflammation and normal appendix harder to see
  - Fluid filled sb may look like appendix

Diagnostic Imaging in Children MRI

- Preliminary Data suggests that MRI without contrast provides diagnostic accuracy similar to CT
- Observational Study 208 Children
  - Sensitivity and Specificity- 98% and 97%
  - Median time from request to report 123 minutes
    - Moore et al Pediatric Radiology 2012
- Observational Study 42 children
  - Sensitivity and Specificity 100 % and 99 %

Appendicitis in Children When and How to Image

- Increased use of CT since mid 1990's have not contributed substantially to lower rates of NAR and perforation rate as high as 33% raising concerns about use of ionizing radiation
  - Martin et al J Pediatr Surg 2004
  - Patrick et al J Pediatr Surg 2003
- For children with low clinical risk- Observe without imaging
- Classical presentation- Surgery without imaging
- For children who have atypical or equivocal findings on clinical and lab evaluation- Image
- Ultrasound and CT used separately or in combination
  - ACR recommends US to be followed by CT
- Established protocol may be useful

Approach in Children Analgesia

- 108 Children(age 5-16years) with suspected appendicitis who received IV Morphine
  - Morphine not associated with perforation, NAR or admission compared to placebo
    - Green et al Pediatrics 2005
- 90 Children (age 8-18 years)
  - Morphine not associated with risk of perforation
  - Dose of 0.1mg/kg did not decrease pain
    - Bailey et al Ann Emerg Med 2007

Management in Children
Timing of Surgery

- Do we have to operate in the middle of the night?
- Limited evidence- Adverse outcomes (perforation, complications, increased operating times) not increased for patients who undergo appendectomy > 6 hours after dx
  - Ingram et al Arch Surg 2010
  - Yardeni et al J Pediatr Surg 2004

Management in Children Perforation/Gangrene

- Perforation without mass or phlegmon
  - 131 children < 18 years – Unblinded randominzed to early surgery vs conservative treatment followed by interval appendectomy
    - Early Surgery associated with significantly shorter time to normal activites and reduced adverse events (e.g. abscess, sbo, unplanned readmission) 30-55%

Blakely et al ArchSurg 2011

Management in Children Mass/Phlegmon

- Recurrence rates also approximately 20% and mostly in first 6 months
- Higher rate of recurrence with appendicolith
- Risk of missing malignancy much less
- Decision on a case by case basis

Management in Children Antibiotics vs Surgery

- Evidence in children is lacking
- Currently several trials are ongoing to address this question

Thank You