

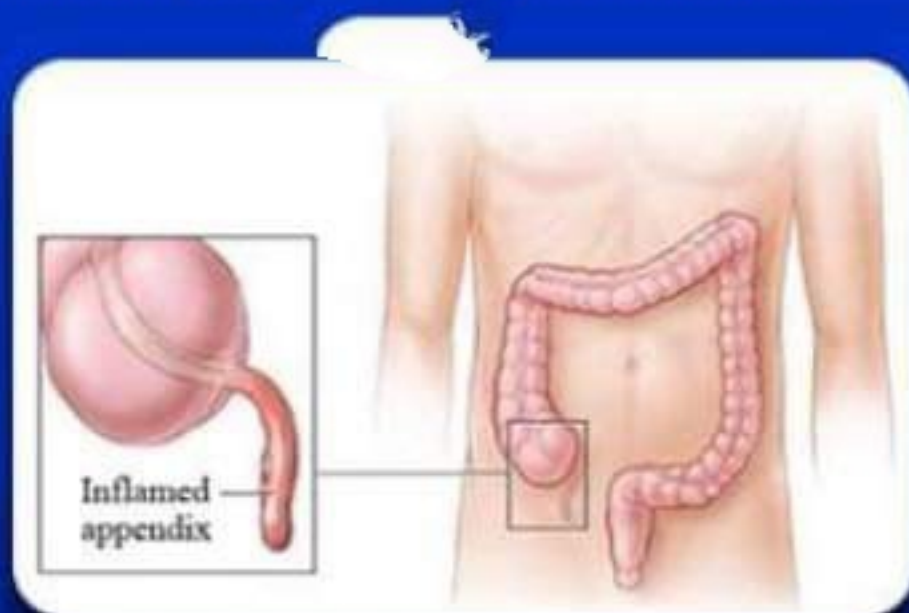
Appendicitis in Children

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History

- First mention 500 years ago
- Appendicitis suspected in 1827
- Fitz coins “appendicitis” in 1886
- First appendectomy 1735
 - Amyand - Scrotal abscess
- First deliberate appendectomy in USA in 1887 for perforated appendicitis
- McBurney does appendectomy before rupture in 1889
 - Describes point of maximal pain
 - “McBurney’s Point”

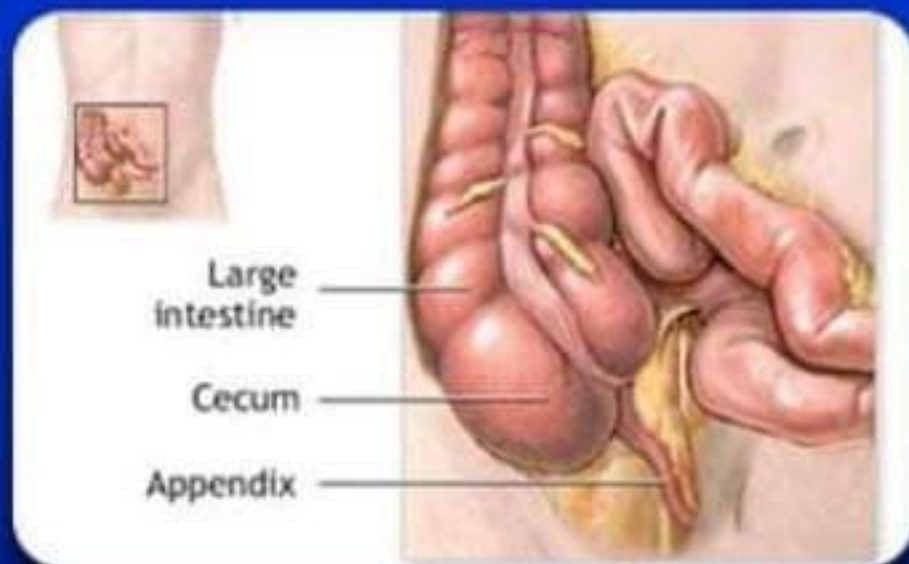
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Embryology & Anatomy

- First visible during week 8
- Position variable
 - Intraperitoneal 95%
 - In pelvis 30%
 - Behind cecum 65%
 - Retroperitoneal 5%
- Always arises at junction of teniae coli
- Function Unknown
 - Primates and rabbits only mammals to have appendix

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Appendicitis

- Most likely caused by luminal obstruction
 - Insipated fecal material
 - Ingested foreign body
 - Parasites
 - Lymphoid hyperplasia



Pathophysiology

- Most likely caused by luminal obstruction
 - Mucous production
 - Bacterial proliferation
 - Increased intraluminal pressure
 - Impaired lymphatic and venous drainage
 - Compromised arterial inflow
 - Tissue Ischemia
 - Necrosis
 - Perforation



Incidence

- Most common cause of acute surgical abdomen in children
- Lifetime risk:
 - 8.67% for boys
 - 6.7% for girls
- Peak Incidence between 12 and 18 years
 - Rare under the age of 5
- Genetic predisposition, especially in children with appendicitis before age 6

Significance

- In the USA, 70,000 children annually diagnosed with appendicitis
 - 1 per 1000 children per year
- \$630 million charges

Diagnosis

- Best made with careful history and physical
- Often deviates from classic description
- Differential diagnosis varies with age of child

Classic Description

- Anorexia, then vague periumbilical pain
- Pain migrates to Right Lower Quadrant
- Nausea and Vomiting follow pain
- Diarrhea may occur
- Fever, if present, is low grade
- Appendix commonly ruptures 24-48 hours after onset of symptoms

Physical Exam

- Tenderness near McBurney's point
 - Retrocecal appendix or obese children, and some ethnic groups may have less tenderness
 - Psoas sign
 - Obturator sign
 - Rovsing's sign
- Digital rectal exam useless in evaluation of appendicitis in children
- Mass in RLQ may be missed if guarding

Differential Diagnosis

- Constipation
- Gastroenteritis
- Mesenteric adenitis
- Pneumonia
- Meckel's Diverticulitis
- Inflammatory Bowel Disease
- Cholecystitis
- Pancreatitis
- Typhlitis
- Urinary tract infection
- Pelvic inflammatory disease
- Ovarian pathology (tumor, torsion)

Constipation

- Most frequent cause of abdominal pain in children
 - Most common reason children present to the emergency room
 - Symptoms may be indistinguishable from appendicitis
 - Abdominal x-ray may demonstrate fecal loading
 - Dietary modifications, medications

Mesenteric Adenitis

- Abdominal lymphadenitis secondary to viral illness
 - Acute swelling of lymph nodes in mesentery causes abdominal pain
 - Highest concentration of lymph nodes near terminal ileum
 - Symptoms may be indistinguishable from appendicitis
 - Self-limiting

Pneumonia

- RLL pneumonia may present as abdominal pain, especially in younger children
 - Fever, leukocytosis, abdominal pain in child <5 years old should be evaluated for pneumonia
 - Symptoms may be indistinguishable from appendicitis



Meckel's Diverticulum

- Rule of 2's
 - 2% population
 - 2 feet from ileocecal valve
 - 2 types of ectopic mucosa
- Should be suspected in children with negative exploration for appendicitis



Back to Appendicitis

Laboratory studies

- Leukocyte count

- Usually mildly elevated (11-16,000)
- Markedly elevated = perforated appendicitis or alternative diagnosis

- Urinalysis

- Free of bacteria, may have few RBC or WBC
- Usually concentrated with ketones

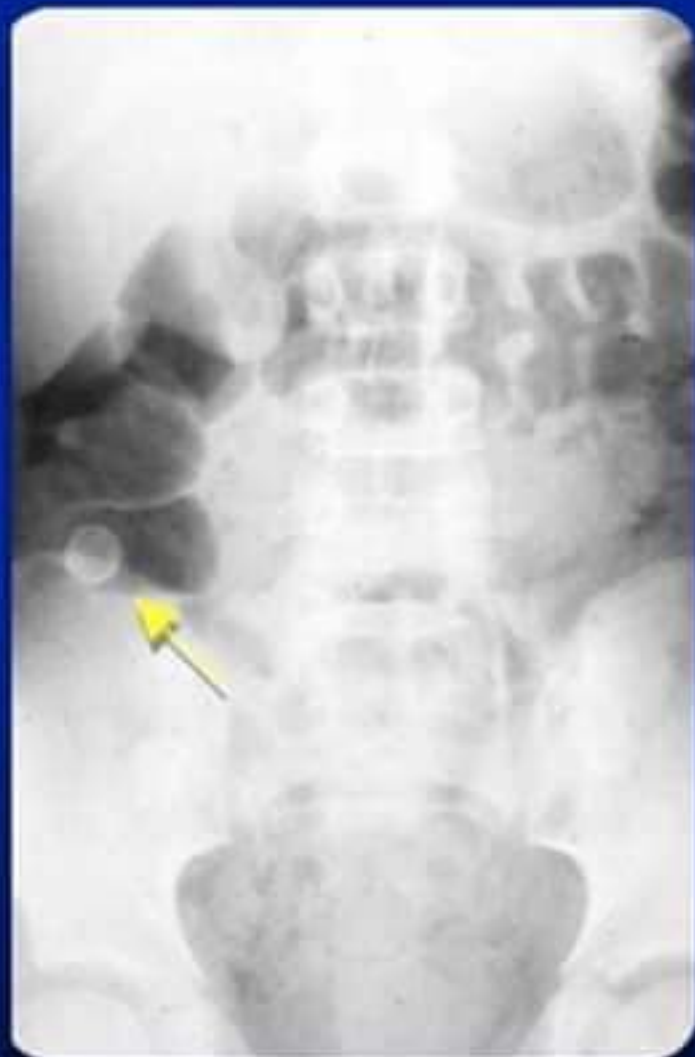
- Electrolytes/LFTs

- Normal

Imaging

● Plain films

- Sentinel loops (localized ileus)
- Mild scoliosis (Psoas spasm)
- Fecolith (10-15% perforated appendicitis)
- Low sensitivity = not recommended



Imaging

● Ultrasound

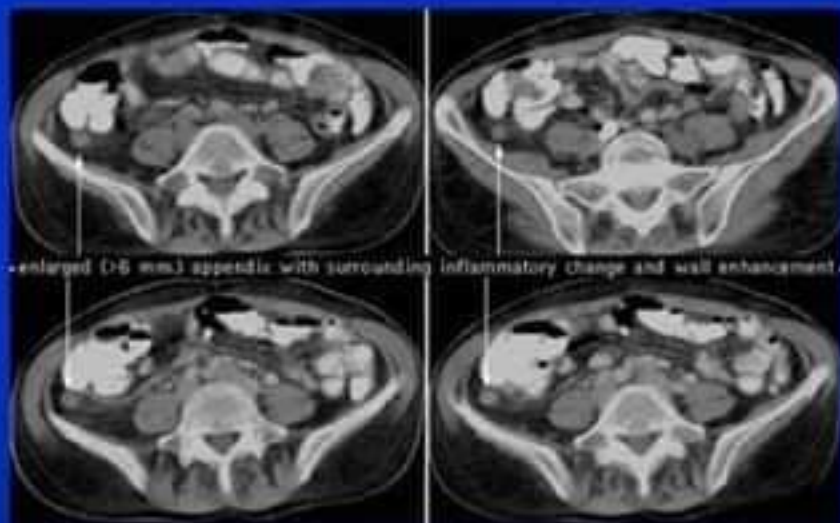
- Specificity 90%, Sensitivity 50-92%
- Normal appendix must be seen to exclude appendicitis
- Positive criteria
 - Noncompressible tubular structure 6mm or greater
 - Complex mass in RLQ
 - Fecolith



Imaging

■ CT scan

- >95% sensitivity and specificity
- Thickened appendix
- Periappendiceal fat stranding
- Fecalith
- Abscess or phlegmon



CT scans

- Highly accurate, but are they necessary?
 - More expensive than ultrasound
 - May require contrast administration
 - Exposure to ionizing radiation
 - One CT equivalent to 100 plain abdominal films
 - Single CT scan carries average 1/1000 lifetime mortality risk from radiation-induced malignancy
 - Imaging has not changed negative appendectomy rate

Care Algorithm

- History and Physical
 - If “classic” - no need for imaging
 - If “equivocal” - may proceed with imaging or observation
 - U/S first choice, except in obese or likely other dx
 - Best choice to image ovaries
 - Diagnostic accuracy improved with repeat exams and labs over 12 to 24 hours
 - Fewer than 2% of appendixes will rupture while under observation

Treatment

- Intravenous fluids
- Antibiotics
- Appendectomy
- Non-operative therapy may be considered for those with perforated appendicitis
 - Children who fail to improve in 24-72 hours will need appendectomy
 - High failure rate if significant bacteremia in differential

Treatment

- Immediate vs. Delayed Appendectomy
 - No need to operate in middle of night with hemodynamically stable child with appendicitis
 - No change in perforation rate or complications
 - Findings seem to be more indicative of initial presentation

Treatment

- Interval Appendectomy

- Employed 6 weeks after non-operative treatment for perforated appendicitis
- Risk of recurrent appendicitis may be 15%
- Others claim risk not as high and interval appendectomy is unnecessary

Treatment

- Laparoscopic vs. Open Appendectomy
 - Laparoscopy proven at least equivalent, if not superior to open appendectomy
 - Post-op course related more to severity of appendicitis than to procedure performed
 - Cosmesis much improved



Evolution

Single Site Surgery

- When compared to standard laparoscopy:
 - No change in operative time
 - Similar post-op analgesia
 - No significant complications
 - Excellent cosmesis

Treatment

- **Post-operative course dictated by operative findings**
- **Montreal Protocol**
 - **Simple Appendicitis**
 - **Preoperative dose of antibiotics**
 - **Discharge home POD#1**
 - **No additional antibiotics**
 - **Complicated (Perforated or Gangrenous) Appendicitis**
 - **Intravenous antibiotics for at least 48 hours**
 - **Antibiotics continue as long temperature spikes above 37.5C**
 - **When afebrile for >24hrs, check WBC**
 - **if WBC > 10, home on oral antibiotics**
 - **if WBC < 10, home without antibiotics**

Summary

- Appendicitis is a common cause of abdominal pain in children
- A careful history and physical can reliably make diagnosis in majority of cases
- Minimally invasive appendectomy is treatment of choice
- Post-operative management is determined by operative findings