



# APPENDICITIS IN *CHILDREN*

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# OBJECTIVES

- ❑ **Review** the pathophysiology of appendicitis in children
- ❑ **Discuss** the diagnosis of appendicitis
- ❑ Differentiate between acute and perforated appendicitis
- ❑ Identify **treatment options** for pediatric appendicitis

# HISTORY

■ **Fitz** coins “appendicitis” in 1886

■

■ **First** deliberate appendectomy in USA in 1887 for perforated appendicitis

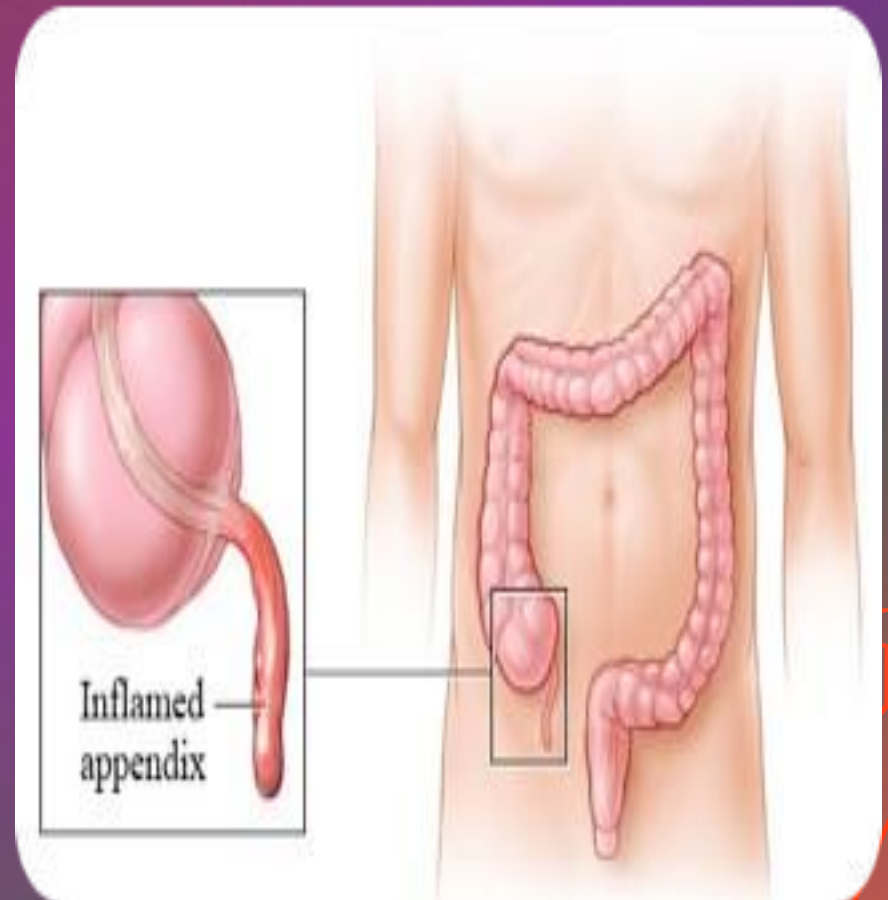
■ **McBurney** does appendectomy before rupture in 1889

■

Describes point of maximal pain

■

“McBurney’s Point”



# EMBRYOLOGY & ANATOMY

■ First visible during week 8

■ Position variable

■ Intraperitoneal 95%

■ In pelvis 30%

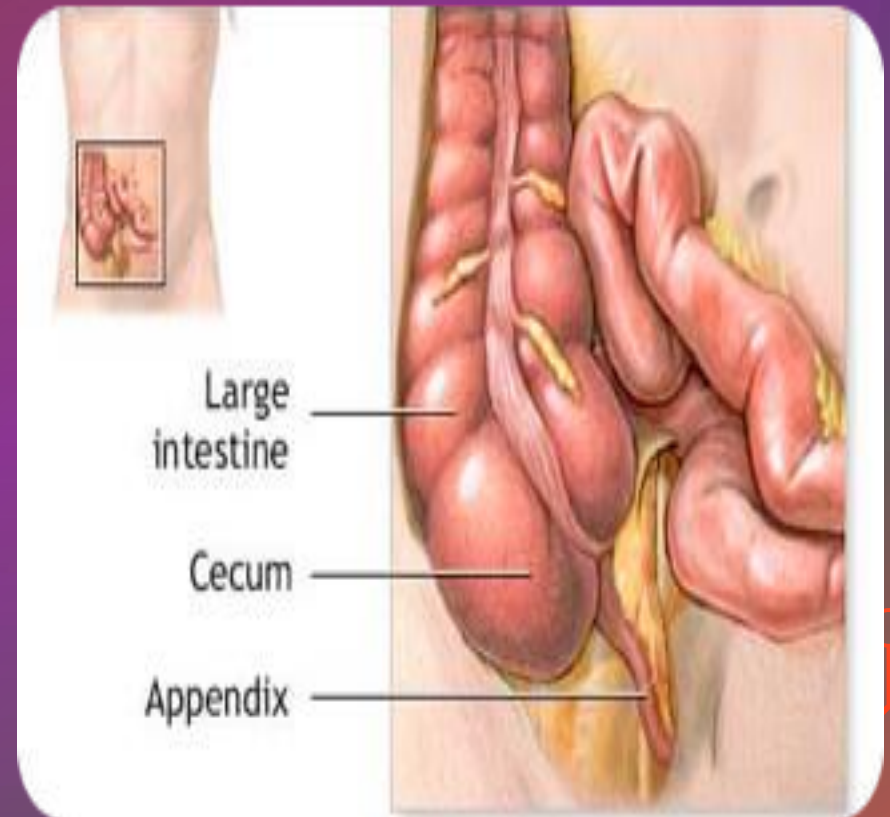
■ Behind cecum 65%

■ Retroperitoneal 5%

■ Always arises at junction of teniae coli

■ Function Unknown

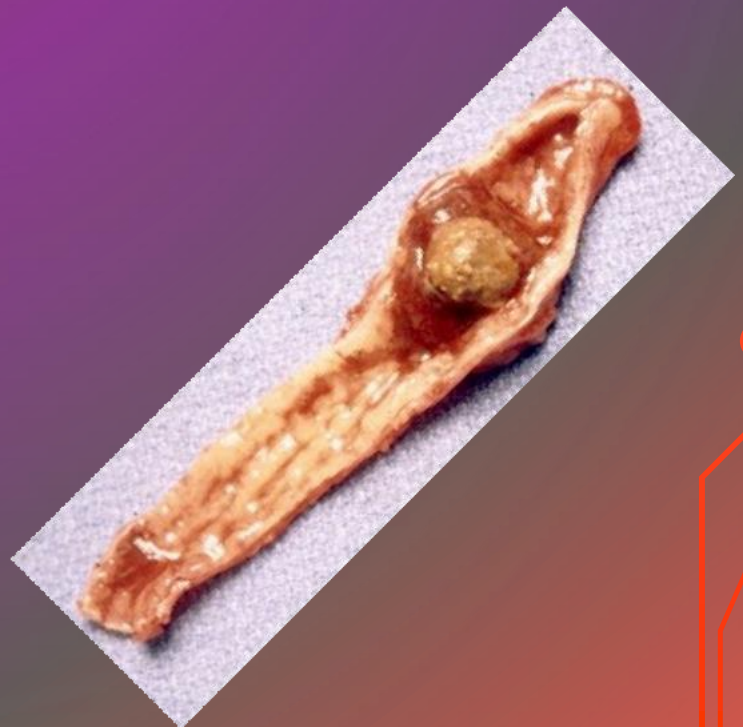
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# APPENDICITIS

- ❑ Most likely caused by **luminal obstruction**
  - ❑ Impacted 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 (peak 11-12)
  - Rare under the age of 5
- Genetic predisposition, especially in children with appendicitis before age 6

# CLINICAL COURSE

- **Simple**
  - Acute appendicitis
  - Suppurative appendicitis
- **Complicated**
  - Gangrenous appendicitis
  - Perforated appendicitis





# DIAGNOSIS

❑ Best made with careful history and physical examination

Laboratory investigations

Scoring systems

# CLINICAL PRESENTATION

- Children with appendicitis **usually lie in bed with minimal movement.**
- **Older children** may **limp or flex the trunk**
- Infants may flex their right leg over the abdomen



# CLASSIC DESCRIPTION

❑ Anorexia(helpful sign), 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

# CLASSICAL FEATURES

- • Periumbilical colic
- • Pain shifting to the right iliac fossa
- • Anorexia
- • Nausea
- • Indigestion or subtle changes in bowel habits
- • Diarrhea



# AGE DEPENDENT SIGNS AND SYMPTOMS

Age Group	Historical Features
Infancy	Vomiting, diarrhea, irritability, fever, unusual use of right hip
Preschool	Abdominal pain, fever, vomiting, "hamburger sign," vomiting followed by pain
School age and adolescence	Periumbilical pain that localizes to right lower quadrant, associated with nausea, vomiting, anorexia

# ATYPICAL PRESENTATION

- **retrocecal appendix**

- Absent of muscular rigidity and tenderness to deep palpation.
- Exacerbation of pain on hip extension (psoas sign) may occur.

- **If the appendix is subcecal/pelvic**

- Present of rectal or vaginal tenderness on right side.
- Absent of abdominal tenderness.

- **If appendix is pre- ileal or post- ileal,**

- The patient may present with vomiting or diarrhea

- Appendix can also be found on the left side in 0.2% of population.

# 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

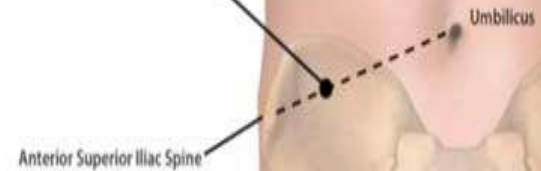
# PHYSICAL EXAMINATION

- Presence of **LOCALIZED ABDOMINAL TENDERNESS** the **SINGLE MOST** reliable finding in the diagnosis of acute appendicitis



## McBurney's Point

2/3 of the way from  
umbilicus to ASIS



- McBurney described :
- “the seat of greatest pain . . . has been very
- exactly between an inch and a half and two inches
- from the anterior spinous process of the ilium on a
- straight line drawn from the process to the
- umbilicus.”
- From then on, this location was known as the
- McBurney point

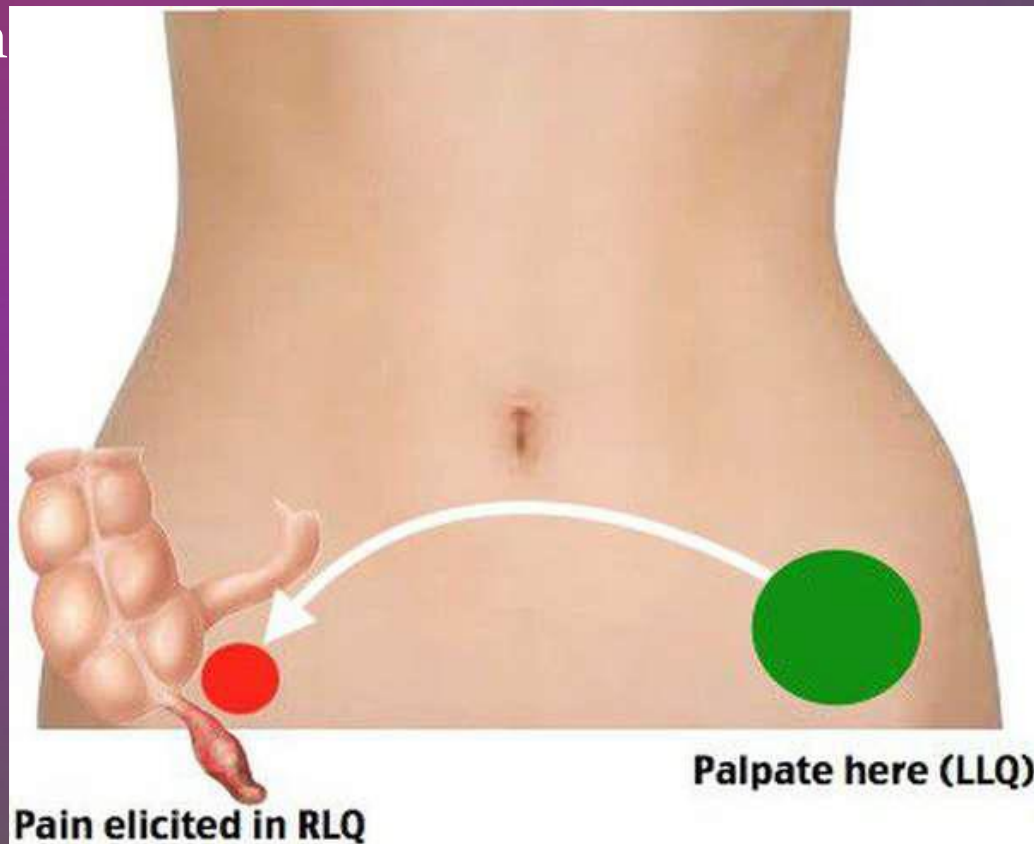
# Other signs

- **Psoas sign** – Hip extension
- **Obturator sign** – Rotation of right flexed hip



# ROVSING'S SIGN

- Palpating in **the left lower** quadrant causes pain in the right lower quadrant



# 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

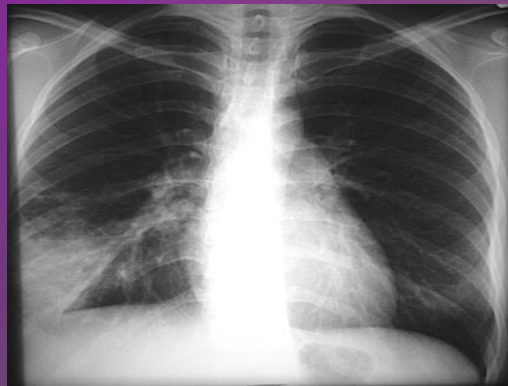
# MESENTERIC ADENITIS

■ 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





The background is a gradient from purple to blue. In the corners, there are decorative orange lines resembling circuit traces or neural network connections, with small circles at the endpoints.

# 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

2 Plain films

2 Sentinel loops (localized ileus)

Mild scoliosis (Psoas spasm)

2 Fecolith (10-15% perforated appendicitis)

2 Low sensitivity = not recommended



# IMAGING

## ■ Ultrasound

- Specificity 90%, Sensitivity 50-92%
- Normal appendix must be seen to exclude appendicitis
- Positive criteria

**Noncompressible tubular structure  
7mm or greater**

- Complex mass in RLQ
- Fecolith

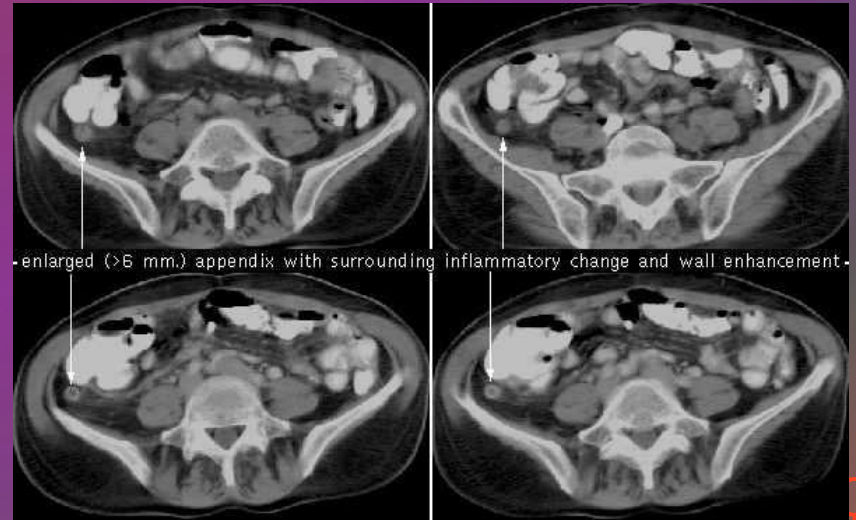


# IMAGING

## CT scan

?

- ? Thickened appendix
- ? Periappendiceal fat stranding
- ? Fecalith
- ? Appendiceal wall enhancement
- ? 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

# CLINICAL SCORING SYSTEM

- The ALVARADO Score

- Symptoms Score

- Migratory pain 1                      Anorexia 1                      Nausea and vomiting 1

- Signs

- Tenderness 2      Rebound tenderness 1                      Elevated temperature 1

- Laboratory

- Leukocytosis 2      Shift to left(segmented neutrophils) 1

- $T < 3$  – low likelihood

- 4-6 – needs further evaluation

- $> 7$  – high likelihood total 10

## • Paediatric appendicitis scores

- Fever  $>38^{\circ}\text{C}$  1
- Anorexia 1
- Nausea/Vomiting 1
- Cough/percussion/hopping tenderness 2
- Right lower quadrant tenderness 2
- Migration of pain 1
- Leukocytosis  $> 10,000/\text{L}$  1
- Polymorphonuclear neutrophilia  $>7500/\text{L}$  1
- Total 10

# 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 6 to 18 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 during 6h and 6-18 h
- Findings seem to be more indicative of initial presentation

# TREATMENT

## Interval Appendectomy

- Employed **8-12 weeks** after non-operative treatment for perforated appendicitis
- Risk of recurrent appendicitis may be 14%
- 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





■ 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

- **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

- IV Antibiotics continue as long temperature spikes above 37.5C

# 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