

Appendicitis in Pediatrics

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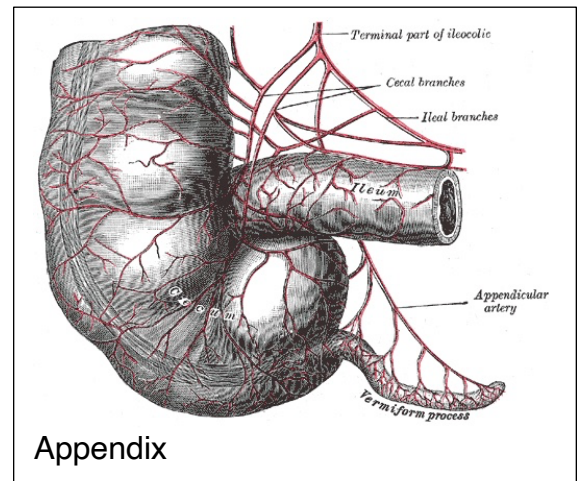
References

Appendicitis in Adults: *See Appendicitis

Pathophysiology

Normal Anatomy

- Arises From the Posteromedial Aspect of The Cecum and Inferior to Ileocecal Junction
- The Tip Has a Variable Location But is Retrocecal in > 60% of Patients ¹
- Typically 6-10 cm Length
- In The First Year of Life, The Appendix is Funnel-Shaped, Perhaps Making It Less Likely to Become Obstructed ²
- Lymphoid Follicles are Interspersed in the Colonic Epithelium That Lines the Appendix and May Obstruct it
- Follicles Reach Their Maximal Size During Adolescence, When Appendicitis Incidence Peaks
- Omentum is Thin and Underdeveloped in Young Children and May Account for The Diffuse Peritonitis That Usually Follows Perforation in This Age Group



Anatomic Location

- Located in The Right Lower Quadrant in the Majority of Normal Children
- May Lie in The Upper Abdomen or On the Left Side in Children with Congenital Abnormalities of Intestinal Position ³
 - Malrotation
 - Situs Inversus Totalis
 - After Repair of Diaphragmatic Hernia
 - Gastroschisis/Omphalocele

Appendicitis Pathology

- Most Commonly Caused by Nonspecific Obstruction of the Appendiceal Lumen ⁴
- Fecal Material (Fecalith) is the Most Common Cause of Obstruction
- Can Also Be Obstructed by Undigested Food or Other Foreign Material
- Less Commonly Caused by Direct Infection or Obstruction from Lymphoid Hyperplasia ⁵
- Common Infectious Agents:
 - Adenovirus ⁶
 - Measles ⁷

Presentation

Epidemiology

- Appendicitis is the Most Common Indication for Emergency Abdominal Surgery in Childhood ⁸
- Diagnosed in 1-8% of Children Evaluated Urgently for Abdominal Pain ⁹
- Incidence in the United States: ¹⁰⁻¹²
 - Birth to 4-Years Old: 1-6 per 10,000 Children
 - < 14-Years Old: 19-28 per 10,000 Children
- < 5% are Diagnosed in Children Under 5 Years Old ¹³

Perforation

- In General, Perforation Correlates with Symptom Duration ¹⁴
- Perforation Rates Vary with Age:
 - Neonates: 50-85% ¹⁵⁻¹⁸
 - Young Children (< 5 Years): 51-100% ¹⁹⁻²⁵
 - School Age (5-12 Years): 11-32% ^{26,27}
 - Adolescents (>12 Years): 10-20% ²⁸⁻³⁰
- Significantly Higher Risk of Perforation at Presentation Than Adults (Particularly in Young Children (< 5 Years Old))
 - Possibly Due to Delayed Presentation
 - Underdeveloped Omentum Has More Difficulty Walling Off an Abscess After Perforation

Presentation/Physical Exam

- Classic Presentation (Usually in Chronologic Order):
 - Anorexia
 - Periumbilical Pain (Early)
 - Vomiting (After Onset of Pain)
 - Migration of Pain to the Right Lower Quadrant
- Location of Pain:
 - Initial Periumbilical Pain is Caused by Appendix Stretching Leading to Stimulation of T8-10 *Visceral* Nerve Fibers
 - Migrating Right Lower Quadrant Pain is Caused by Inflammation of the Surrounding Parietal Peritoneum Leading to Stimulation of the *Somatic* Nerve Fibers
- Additional Signs/Symptoms:
 - **McBurney Sign:** Right Lower Quadrant Tenderness at McBurney's Point (1/3 the Distance from the Anterior-Superior Iliac Spine (ASIS) to the Umbilicus)
 - Pain with Movement – Ambulation or Shifting in Bed
 - Fever (Commonly 24-48 Hours After Symptom Onset)
 - Difficulty Ambulating
 - Lethargy, Irritability (Neonates and Young Infants)
- Signs of Peritoneal Irritation:
 - Localized Right Lower Quadrant Tenderness by Cough, Hopping, or Bumping the Exam Table
 - Involuntary Muscle Guarding with Palpation
 - Rebound Tenderness
 - **Rovsing Sign:** Right Lower Quadrant Pain with Left Lower Quadrant Palpation
 - **Iliopsoas/Psoas Sign:** Right Lower Quadrant Pain on Extension of the Right Thigh
 - Indicates a Retrocecal Position of the Appendix
 - **Obturator Sign:** Right Lower Quadrant Pain on Internal Rotation of Right Thigh
 - Indicates a Pelvic Position of the Appendix

Diagnosis

Acute Appendicitis is a Clinical Diagnosis and Should Be Considered in All Children Who Present with Abdominal Pain and Abdominal Tenderness on Physical Exam

Diagnosis

- **Labs:**
 - WBC/ANC on CBC with diff – Elevated in Up to 96% of Patients ²⁹
 - C-Reactive Protein (CRP)
 - Use of Both WBC and CRP in Pediatrics Has High Sensitivity and Negative Predictive Value (99%) but Lower Positive Predictive Value (50%) ³⁰
 - Urinalysis Routinely Performed to Identify Alternative Conditions (UTI, Nephrolithiasis)
 - Patients with Appendicitis May Have Incidental Pyuria ³¹
 - Urine b-hCG Pregnancy Test in All Postmenarchal Females

- **Imaging:**
 - Can Be Helpful in Children Who Do Not Present with Typical Signs and Symptoms
 - Children with a Typical Presentation are Considered High Risk for Acute Appendicitis and Consultation with a Pediatric Surgeon Should be Obtained Prior to Imaging
 - Imaging May Be Unnecessary
 - Children with Low Risk for Acute Appendicitis Based on Exam and Labs May Be Managed without Imaging and Instead with Serial Abdominal Exams and Strict Return Precautions
 - Children with Atypical or Equivocal Clinical Findings Suggests Moderate Risk and Warrants Imaging with Ultrasound Being the Preferred Study
 - Adolescent Females Warrant Pelvic Ultrasound with Doppler to Rule Out Ectopic Pregnancy and Ovarian Pathology

Complicated Definitions

- **Uncomplicated (Early) Appendicitis:** Acute or Suppurative Appendicitis
- **Complicated (Advanced) Appendicitis:** Transmural Bacterial Contamination of the Peritoneal Cavity in Gangrenous or Perforated Appendicitis

Scoring Systems

- **Pediatric Appendicitis Score (PAS)** ³²
 - The Most Commonly Used System in Pediatrics
 - Points:
 - RLQ Tenderness (2)
 - Pain with Cough, Percussion or Hopping (2)
 - Anorexia (1)
 - Nausea/Emesis (1)
 - Migration of Pain (1)
 - Fever > 38°C/100.5°F (1)
 - Leukocytosis; WBC > 10,000 cells/microL (1)
 - Neutrophilia; ANC > 7,500 cells/microL (1)
 - Interpretation:
 - Low Scores (0-3): Evaluate Other Etiologies
 - Intermediate Scores (4-6): Obtain Imaging to Further Evaluate
 - High Scores (7-10): Imaging vs Surgery
- **Alvarado Scoring System** ³³
 - The Most Commonly Used System in Adults
 - Points:
 - Tenderness in RLQ (2)
 - Migration to RLQ (1)
 - Rebound Tenderness (1)
 - Anorexia (1)
 - Nausea/Vomiting (1)
 - Elevated Temperature (1)
 - Leukocytosis; WBC > 10,000 (2)
 - Shift of Neutrophils (1)

Treatment

Definitive Management

- **Uncomplicated Appendicitis:**
 - Laparoscopic (Over Open) Appendectomy Recommended ³⁴
 - Non-Operative Management with Antibiotics May Be Considered for Select Low-Risk Patients – Surgery is Still Generally the Standard of Care
- **Complicated Appendicitis:**
 - *Phlegmon or Abscess*: Antibiotics and Interval Appendectomy at 10-12 Weeks
 - Percutaneous Drainage Any Abscess > 3 cm ³⁵
 - May Require Urgent Appendectomy if Otherwise Ill-Appearing
 - *Gangrenous or Free Perforation*: Urgent Appendectomy ³⁶

Antibiotics

- All Patients Should Receive Broad-Spectrum IV Antibiotics to Cover Colonic Flora as the Diagnosis is Established ³⁷
- Postop Duration:
 - *Uncomplicated*: None Necessary
 - *Gangrenous But Not Perforated*: Stop Within 24 Hours
 - *Abscess Drained*: 4-Days After Source Control
 - *Free Perforation*: Generally Continued for 4-5 Days Postop
 - May Consider Discharge on Oral Antibiotics if Discharge Criteria Met (Afebrile, Return of Bowel Function, Adequate PO Intake, and Pain Controlled)

Nonoperative Management

- Requirements:
 - Abdominal Pain < 48 Hours
 - WBC < 18,000
 - CRP Not Elevated
 - No Peritoneal Signs
 - Imaging Showing:
 - Appendix Diameter ≤ 1.0 cm
 - No Appendicolith
 - No Signs of Perforation
- Management:
 - Start with IV Antibiotics for 1-2 Days
 - Can Discharge Home on Oral Antibiotics for a 7-10 Day Total Course Once Signs/Symptoms Resolve and WBC Has Normalized ³⁸
- Comparison to Surgical Management:
 - May Avoid Surgery (80-90% Avoid Surgery at the Initial Admission)
 - May Have a Faster Return to Activity (Shorter Duration of Disability)
 - High Recurrence Rates (40-50% at 5-Years)

Differential Diagnosis/Similar Emergency Surgical Pathology

- Bowel Obstruction
- Intestinal Malrotation
- Intussusception
- Ovarian Torsion
- Ectopic Pregnancy
- Testicular Torsion
- Omental Torsion

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