Radiologic Diagnosis of Appendicitis

Arabinda Pani,
Harvard Medical School, Year III

Gillian Lieberman, MD
Overview

• Introduction: Epidemiology, Pathophysiology
• Role of Radiologic diagnosis
• Normal anatomy
• Appearance in various modalities
• Criteria for radiologic diagnosis
• Patient Case: Appendicitis in Pregnancy
Epidemiology

- Appendicitis-associated abdominal pain is a common presentation to ED
- Peak Incidence: 10 – 30 years of age
- Lifetime incidence: 7% in United States
- Historically, high rate of false negatives and false positives
  - 20% of diagnoses initially missed
  - 20% of appendectomies revealing a normal appendix
Pathophysiology

- The lumen of the appendix becomes obstructed, leading to increased intraluminal pressure resulting in inflammation, ischemia, and infection
- Obstruction is most often secondary to:
  - Appendicoliths
  - Lymphoid hyperplasia
  - Parasite infections
  - Tumors (carcinoid, metastatic)
  - Foreign bodies
Complications of Appendicitis

- Perforation
- Abscess formation
- Generalized peritonitis
- Small bowel obstruction

The rate of complications increases with time until diagnosis and treatment.
Classic Presentation

- Dull, generalized abdominal pain, migrates to RLQ over 24 hours
- Nausea, Vomiting, Anorexia

- Low-grade fever
- Abdominal tenderness
- Guarding
- Rebound tenderness
- Obturator and Psoas Signs
- Elevated WBC
Role of Radiologic Diagnosis

- Appendicitis is highly prevalent
- Often presents atypically especially in children, women and the elderly
- Complications are common and time-dependent

Radiologic Diagnosis:
- Is effective in significantly increasing diagnostic accuracy
- Decreases morbidity and mortality by:
  - preventing complications
  - avoiding unnecessary surgeries
- Lowers the overall cost of healthcare
Anatomy

Gray’s Anatomy

adam.com
Normal Appendix

contrast-filled appendix on barium study

contrast in appendix (CT)

http://www.emedicine.com/radio/topic47.htm
Ultrasound: Normal Appendix

Longitudinal ultrasonography shows compressible tubular structure with an outer diameter of less than 6 mm. A=Iliac artery; V=Iliac vein.

http://emedicine.com/radio/topic47.htm
Normal Appendix: MR

- Low Signal Intensity
- Non-distended

Courtesy Dr. Eric Zeikus, PACS:BIDMC
Radiologic Findings of Appendicitis

- Inflammatory changes
- Lumenal obstruction
- Appendicoliths

Plain Film
- Film is normal in > 50% of patients with appendicitis
- Only 10% demonstrate a calcified, laminated appendicolith(s)
- Other findings are non-specific

Barium Enema
- Diagnostic criteria requires visualization of a non-filling appendix
- Often non-diagnostic with low sensitivity
- Invasive
Plain Film: Calcified Appendicolith

http://telesalud.ucaldas.edu.co
Graded Compression Ultrasound

- Blind-ended, tubular, **noncompressible**, aperistaltic structure
- Diameter > 6 mm, laminated wall
- Increased periappendiceal echogenicity
- Appendicolith: echogenic with distal shadowing
- Doppler: increased circumferential flow
- Perforation/Abscess: thickening of adjacent bowel wall, fluid collections, hypoechoic mass

Overall diagnostic accuracy: 85%
Appendicitis on Ultrasound

- Non-compressible, blind-ended
- 8mm diameter
- Laminated wall

Color Doppler Ultrasound

Circumferential Flow, suggestive of hypervascularity and inflammation

Appendicolith on US

- Bright, echogenic focus
- Clean distal acoustic shadowing

Perforated Appendix on US

- Perforated Appendix with Free Peritoneal Fluid (FF) surrounding loops of bowel (B).

http://lunis.lumc.edu/radiology/Appendicitis
CT Diagnosis

**Primary Criteria:**
- Enlarged, inflamed appendix
  - diameter >6 mm in adults
  - > 8mm in children
- Appendicolith
- Non-contrast filled

**Secondary Criteria:**
- Wall enhancement
- Fat stranding
- Abscess formation
- Focal thickening of the cecum (arrow-head sign)
- Adenopathy
- Small bowel obstruction
- Free fluid in the pelvis

**Overall Accuracy:** 98%
Uncomplicated Appendicitis: CT

- Non-contrast filled
- Enlarged appendix, 14 mm in diameter
- Adjacent fat stranding

Courtesy of Dr. Michael Geary, PACS: BIDMC
Coronal CT: Enhancing Wall
CT: Appendicolith

http://www.madisonradiologists.com/SvcCTAbdominalPain.htm
Arrowhead Sign

Mural thickening of the cecum at the base of an obstructed appendix
Periappendiceal Abscess

Courtesy of Dr. Damon Soeiro; PACS: BIDMC
Coronal CT: Abscess
Our Patient

Otherwise healthy, 33 year old female at 20 weeks gestation, presented to ED with 6 days of abdominal pain.

Pain was described as epigastric and crampy in nature.

Denied nausea, vomiting. Reported loss of appetite, chills, and a low-grade fever.

Temp 99.4  WBC: 10.2

Abdomen: soft, gravid, diffusely tender to palpation; no rigidity or rebound tenderness
Diagnostic Complications in Pregnancy

- Pregnancy alters the position of the appendix
- Atypical clinical presentation
- Increased risk of perforation
- Association with premature labor, decreased birth weight

- Ultrasound is modality of choice but diagnosis can be impeded by body habitus and anatomic displacement of the appendix
- CT exposes the fetus to radiation
Patient Evaluation by Ultrasound

- Focal rounded area of increased echogenicity with a hypoechoic rim and increased vascularity suspicious for an inflamed appendix
- Localized to the patient’s area of tenderness
- Noncompressible
Doppler Ultrasound Findings

- Transverse view demonstrated increased circumferential flow in the wall of the appendix, suggestive of hypervascularity secondary to inflammation
Diagnosis of Appendicitis in Pregnancy

Advantages of MR

- Visualize an abnormal appendix in atypical locations
- Visualize adjacent inflammatory processes
- Different sequences +/- contrast
- No known biologic risks to fetus

Diagnostic Findings

- Enlarged appendix > 6mm
- Periappendiceal inflammatory changes
- T2/fat-suppressed images: high signal intensity of an inflamed appendix
HASTE Sequence, Coronal View

- Appendix location: posterior and superior to the uterus
- Distended at: 10 mm in the middle; 18 mm at tip
- Associated fat stranding

Courtesy of Dr. Eric Zeikus, PACS: BIDMC
Sagittal View

- Fluid-filled lumen
- Thickened wall
Conclusion of Case

- Patient proceeded to surgery for a laparoscopic appendectomy, performed without complications.
- On gross appearance, the appendix was inflamed and gangrenous.
- Post-op ultrasound demonstrated a normal, unchanged fetus.
- Pathology: specimen consistent with acute appendicitis with evidence of perforation
- The mother carried fetus to term, delivered without complications.
Acknowledgements

• Michael Geary, MD
• Arati Khanna, MD
• Damon Soeiro, MD
• Atif Zaheer, MD
• Eric Zeikus, MD
• Gillian Lieberman, MD
• Pamela Lepkowski
• Larry Barbaras
References