

*Emergency Radiology, 1st Nordic Course  
Gothenburg, Sweden, May, 2007*

# Right Lower Quadrant Pain

Robert A. Novelline, MD  
Professor of Radiology, Harvard Medical School  
Director of Emergency Radiology,  
Massachusetts General Hospital



## Differential Diagnosis: RLQ Pain

### Gastrointestinal

Appendicitis  
Diverticulitis  
Epiploic Appendagitis  
Segmental Omental Infarction  
Ileocolitis  
Mesenteric Adenitis  
Cecal Carcinoma  
Crohn Disease  
Meckel Diverticulitis  
Cholecystitis

### Gynecological

Hemorrhagic Ovarian Cyst  
Ruptured Ovarian Cyst  
Ectopic Pregnancy  
Adnexal Torsion  
Pelvic Inflammatory Disease  
with Tubo-Ovarian Abscess  
Degenerating Uterine  
Leiomyoma

### Urological

Nephrolithiasis  
Pyelonephritis  
Hydronephrosis

# Intraperitoneal Causes of RLQ Pain

- Appendicitis
- Mimics of Appendicitis:
  - Right-sided Diverticulitis
  - Sigmoid Diverticulitis extending to the right
  - Epiploic Appendagitis
  - Mesenteric Adenitis
  - Mesenteric Panniculitis
  - Segmental Omental Infarction
  - Crohn Disease
  - Tubo-Ovarian Abscess
  - Acute Cholecystitis

## Appendicitis

- Most common acute surgical condition of abdomen
- 7% population will have appendicitis in their lifetime
- Peak incidence: ages 10 – 30 years
- 250,000 new cases/year in USA
- Approximately 10 to 30% frequency of perforation
- Prior to the routine use of CT, 20% of emergency appendectomies revealed a normal appendix

## Presenting Signs and Symptoms of Acute Appendicitis

- |                                 |     |
|---------------------------------|-----|
| • RLQ pain and/or tenderness    | 96% |
| • Duration of symptoms < 5 days | 80% |
| • WBC > 10,000/mm <sup>3</sup>  | 66% |
| • Temperature > 37.5°C (99.5°F) | 63% |
| • Nausea                        | 62% |
| • Vomiting                      | 32% |
| • Rebound tenderness            | 26% |
| • Anorexia                      | 24% |
| • RLQ guarding                  | 21% |

## MGH MDCT Protocol for Appendicitis *Rectal Contrast; Limited MDCT Scan*

- Rectal Contrast:
  - 40cc of 60% contrast in 1000cc saline
- IV Contrast:
  - 75-125cc of 370 concentration @ 3.0 cc/sec
- MDCT Scan Protocol
  - Scan after 150 sec delay
  - Scan from L3 to acetabular roof (reduce radiation)
  - View slices at 2.5mm thickness
  - If reformations needed:
    - 16-slice: 1.25mm at 1.00 spacing
    - 64-slide: Contiguous 0.625mm

# Colon Contrast

## Advantages

- Faster
- Normal appendix fills better
- Cecal apical changes seen better due to cecal distention
- Higher reported accuracy
- Greater interpreter confidence

## Avoids

- Delays
- Nauseated patients do not wish to drink large amounts of contrast
- General anesthesia problems after CT

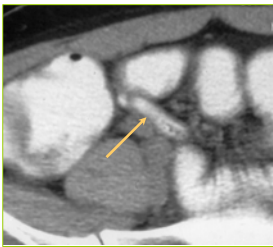
## MGH MDCT Protocol for Appendicitis *Rectal Contrast; Limited MDCT Scan*

- Option: if appendix not seen well on axials:
  - Coronal and sagittal reformations
  - Decubitus scans:
    - Left side down if cecum well-opacified
    - Right side down with more rectal contrast material if cecum not well-opacified
- Option: if no appendicitis seen and no alternative diagnosis identified
  - Extend scan to full abdomen

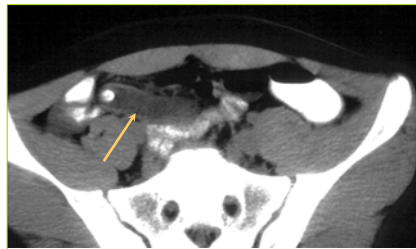
# Finding the Appendix at CT

- Find ileocecal valve as a landmark (40% of patients reflux into terminal ileum)
- Origin of appendix is 2 - 3 cm caudal to valve, and usually posteromedial
- Location: variable
- Follow appendix to its blind-ending tip

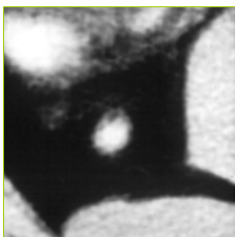
## Normal Appendix at CT<sup>1</sup>



*Normal filled with contrast*



*Appendicitis*



*Normal filled with contrast*



*Normal filled with air*

# CT Signs of Appendicitis

## Abnormal Appendix

- Diameter >6mm
- Fails to completely fill with contrast
- Appendoliths
- Wall thickening
- Wall enhancement with IV contrast

## Periappendiceal Inflammation

- Fat stranding
- Fluid
- Phlegmon
- Extraluminal air bubbles
- Abscess
- Adenopathy

## Cecal Apical Changes

- Focal apical thickening
- Arrowhead sign
- Cecal bar

## Appendoliths



- Are seen in up to 45% of cases using CT
- Must be seen in conjunction with other signs of appendicitis
- May or may not be calcified uniformly
- May contain air

## Peri-Appendiceal Inflammation

- In soft tissues surrounding or adjacent to appendix see fat stranding, fluid, phlegmon, extraluminal air bubbles, abscess or adenopathy
- Adenopathy usually present with appendicitis
  - located anterior to psoas just cephalad to origin of appendix; also see with mesenteric adenitis
- Phlegmon (inflamed soft tissue mass) may prevent visualization of abnormal appendix
  - Value of IV contrast material
- With phlegmon diagnosis appendicitis based on:
  - Appendoliths
  - Cecal apical changes specific for appendicitis

## Cecal Apical Findings

1. Focal cecal apical thickening
2. Arrowhead sign
3. Cecal bar

# Cecal Apical Findings

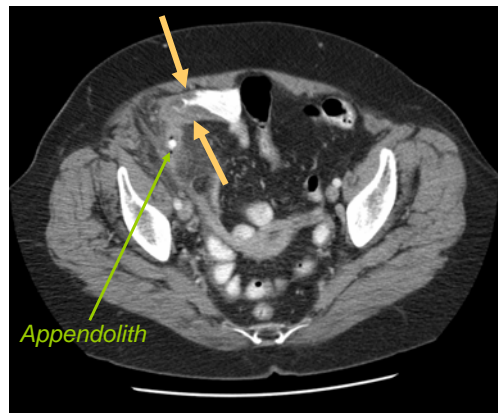
## 1. Focal cecal apical thickening

- Caused by spread of inflammation and edema into wall of cecum
- Complete filling of cecum with contrast is needed to visualize this sign
- The sign is frequent and pathognomonic for appendicitis
  - Focal wall thickening from diverticulitis is centered at the diverticulum, not the cecal apex

# Cecal Apical Findings

## 2. Arrowhead Sign

- Inflammatory thickening of cecal apex with contrast funneling into center of inflammation
- Visualization depends on CT slice coinciding with position of arrowhead
- Arrowhead points toward appendix

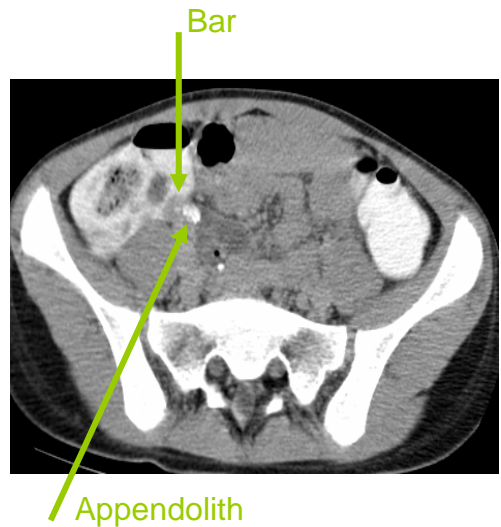




# Cecal Apical Findings

## 3. Cecal bar

- Inflamed soft tissues surrounding an obstructing proximal appendolith
- Thickened bar of soft tissue separates appendolith from lumen of cecum



## \*Appendiceal CT Signs

CT Sign	Sensitivity	Specificity
Fat Stranding	100	80
Enlarged, unfilled appendix	93	100
Focal cecal apical thickening	69	100
Adenopathy	62	66
Appendolith(s)	44	100
Arrowhead Sign	23	100
Dependent fluid	18	86

## \*Appendiceal CT Signs

CT Sign	Sensitivity	Specificity
Abscess	11	100
Cecal Bar	10	100
Extraluminal air	8	97
Phlegmon	7	99
Terminal ileal wall thickening	3	86
Sigmoid wall thickening	3	95
Focal cecal wall thickening	0	98
Diffuse cecal wall thickening	0	91

\*Rao, Rhea, Novelline et al. 1997. *J Comput Assist Tomogr* 21:686

## Appendicitis in Pregnancy

- Imaging Options
  - Ultrasound
  - Limited CT scan
  - MR scan

## \*Distal (Tip) Appendicitis

- Appendicitis usually results from luminal obstruction at the appendiceal orifice
- When lumen is obstructed distal to orifice the resulting condition is “distal/tip appendicitis”
- Lumen of proximal appendix may opacify and appear normal resulting in a false negative diagnosis of appendicitis
- This condition is readily recognized by CT

## Right-Sided Diverticulitis

- Diverticulitis may produce RLQ pain when it involves the cecum and right colon, or when sigmoid diverticulitis extends to the right of midline
- Combination of RLQ pain, fever and leukocytosis mimics appendicitis
- Look for the normal appendix at CT

# Mesenteric Adenitis

Two Types:

- Primary Mesenteric Adenitis
  - Adenitis without an acute inflammatory process
  - May see mild thickening of the terminal ileum
  - Self-limited process that affects lymph nodes in the RLQ
  - Non-surgical condition, more common under 15 years
  - Presentation may mimic appendicitis
  - Etiology: infection viral pathogens, sometimes other organisms
  - Incidence in patients who have CT for suspected appendicitis
  - 12% adenitis as isolated finding
  - 6% adenitis plus ileum wall thickening
- Secondary Mesenteric Adenitis
  - Adenopathy with Crohn Disease, appendicitis, diverticulitis, or neoplasms such as a lymphoma and carcinoma

# CT Findings in Mesenteric Adenitis

- Enlarged (>5 mm shortest dimension) and clustered (3 or more) mesenteric nodes
- Location in RLQ
  - Anterior to psoas
  - Small bowel mesentery
- Adenitis may be seen with small bowel wall thickening (>3 mm)

# Mesenteric Panniculitis

- Non-specific inflammatory and fibrotic process affecting fatty tissues of mesentery
- If predominately fibrosis called “retractile mesenteritis”
- Rare, most cases idiopathic
- Peak incidence sixth and seventh decades
- More common in males
- Present with abdominal pain, fever, nausea, vomiting
- Exam may reveal abdominal tenderness, palpable mass
- Symptoms may persist for a year or more

# CT Findings in Mesenteric Panniculitis

- CT findings may vary:
  - Well-defined soft tissue mesentery mass
  - Ill-defined areas of higher attenuation in the mesenteric fat representing inflammation and fibrosis
- Abnormality often surrounds SMA and SMV
- No involvement of adjacent bowel
- When the process is focal it may mimic a teratomatous or liposarcomatous tumor

# Segmental Omental Infarction

- Rare, 300 cases in literature
- Etiology of infarction
  - Necrosis caused by interruption of blood supply to the omentum from torsion or venous thrombosis, more common on right side
  - *Primary* (idiopathic) or *Secondary torsion* (adhesions, neoplasm, trauma, surgery, hernia)
  - Primary may be precipitated by coughing, straining, overeating
- Clinical presentation
  - Sudden, severe abdominal pain, RLQ or peri-umbilical tenderness, may have fever
- Differential Diagnosis
  - Appendicitis, diverticulitis, cholecystitis
  - Metastases, liposarcoma, secondarily inflamed fat

## CT Findings in Segmental Omental Infarction

- CT shows an abdominal mass (ovoid, cake-like) of fat stranding or fat with dense streaks representing folds within the mass
- Location is superficial and paraumbilical
  - Between rectus abdominis and colon or small bowel
  - Right-sided more than left-sided (right-sided segmental omental infarction)
- Complications: necrosis and abscess

## Crohn Disease

- Inflammatory disease of the distal small bowel which may involve cecum and colon
- May be associated with secondary appendicitis

## Tubo-Ovarian Abscess (TOA)

- Advanced form pelvic inflammatory disease (PID)
- Often caused by *Chlamydia trachomatis* and *Neisseria gonorrhoeae*
- Infection of ovary and fallopian tube with hydrosalpinx and collection of pus
- Present with pain, fever, vaginal discharge
- Usually diagnosed by ultrasound
- CT may show a complex cystic mass representing dilated tubes and the TOA

# Acute Cholecystitis

- In older patients, acute cholecystitis may occasionally present with right-sided abdominal pain mimicking appendicitis
- May have fever and elevated white blood cells
- CT may show: gallbladder distention, mural thickening, wall enhancement, wall irregularity, intraluminal membranes, pericholecystic stranding, pericholecystic fluid, gallstones, gas in the gallbladder wall or in the gallbladder lumen

## Summary: Intra-Abdominal Causes of RLQ Pain

- Appendicitis
- Mimics of Appendicitis:
  - Right-sided Diverticulitis
  - Epiploic Appendagitis
  - Mesenteric Adenitis
  - Mesenteric Panniculitis
  - Segmental Omental Infarction
  - Tubo-Ovarian Abscess
  - Acute Cholecystitis



Robert A. Novelline, MD  
Professor of Radiology, Harvard Medical School  
Director of Emergency Radiology,  
Massachusetts General Hospital

