# Right Lower Quadrant Pain

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Director of Emergency Radiology,  
Massachusetts General Hospital

## Differential Diagnosis: RLQ Pain

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<tr>
<th>Gastrointestinal</th>
<th>Gynecological</th>
<th>Urological</th>
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<td>Appendicitis</td>
<td>Hemorrhagic Ovarian Cyst</td>
<td>Nephrolithiasis</td>
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<tr>
<td>Diverticulitis</td>
<td>Ruptured Ovarian Cyst</td>
<td>Pyelonephritis</td>
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<tr>
<td>Epiploic Appendagitis</td>
<td>Ectopic Pregnancy</td>
<td>Hydronephrosis</td>
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<td>Segmental Omental Infarction</td>
<td>Pelvic Inflammatory Disease with Tubo-Ovarian Abscess</td>
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<tr>
<td>Ileocolitis</td>
<td>Adnexal Torsion</td>
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<tr>
<td>Mesenteric Adenitis</td>
<td>Cholecystitis</td>
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<td>Cecal Carcinoma</td>
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<td>Crohn Disease</td>
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<td>Meckel Diverticulitis</td>
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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/mm³ 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

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**MGH MDCT Protocol for Appendicitis**

**Rectal Contrast; Limited MDCT Scan**

- **Option:** if appendix not seen well on axials:
  - Coronal and saggital 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\textsuperscript{1}

<table>
<thead>
<tr>
<th>Image</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image 1" /></td>
<td>Normal filled with contrast</td>
</tr>
<tr>
<td><img src="image2.png" alt="Image 2" /></td>
<td>Appendicitis</td>
</tr>
<tr>
<td><img src="image3.png" alt="Image 3" /></td>
<td>Normal filled with contrast</td>
</tr>
<tr>
<td><img src="image4.png" alt="Image 4" /></td>
<td>Normal filled with air</td>
</tr>
</tbody>
</table>
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

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

<table>
<thead>
<tr>
<th>CT Sign</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat Stranding</td>
<td>100</td>
<td>80</td>
</tr>
<tr>
<td>Enlarged, unfilled appendix</td>
<td>93</td>
<td>100</td>
</tr>
<tr>
<td>Focal cecal apical thickening</td>
<td>69</td>
<td>100</td>
</tr>
<tr>
<td>Adenopathy</td>
<td>62</td>
<td>66</td>
</tr>
<tr>
<td>Appendolith(s)</td>
<td>44</td>
<td>100</td>
</tr>
<tr>
<td>Arrowhead Sign</td>
<td>23</td>
<td>100</td>
</tr>
<tr>
<td>Dependent fluid</td>
<td>18</td>
<td>86</td>
</tr>
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**Appendiceal CT Signs**

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<tr>
<td>Abscess</td>
<td>11</td>
<td>100</td>
</tr>
<tr>
<td>Cecal Bar</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Extraluminal air</td>
<td>8</td>
<td>97</td>
</tr>
<tr>
<td>Phlegmon</td>
<td>7</td>
<td>99</td>
</tr>
<tr>
<td>Terminal ileal wall thickening</td>
<td>3</td>
<td>86</td>
</tr>
<tr>
<td>Sigmoid wall thickening</td>
<td>3</td>
<td>95</td>
</tr>
<tr>
<td>Focal cecal wall thickening</td>
<td>0</td>
<td>98</td>
</tr>
<tr>
<td>Diffuse cecal wall thickening</td>
<td>0</td>
<td>91</td>
</tr>
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**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 lymphoma and carcinoma

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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
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