IV and Oral contrast vs. IV contrast alone computed tomography for the visualization of appendix and diagnosis of appendicitis in adult ED patients

Aman Wadhwani, MD/MSc-Candidate
Lancia Guo, MD
Erik Saude, MD/PhD
Hein Els, MD
Eddie Lang, MD
Andrew McRae, MD/PhD
Deepak Bhayana, MD
Clinical Presentation

- 56 y.o. male with renal failure presents to the ED with 36 hours history of abdominal pain, anorexia, periumbilical pain
- Progresses to RLQ pain and nausea
- Vitals: T= 39.4 °C, HR= 100, and BP =130/85
- Physical Exam: RLQ rebound tenderness, guarding, pain on palpation
- Emergency physician suspects appendicitis and orders a CT scan to confirm the diagnosis
Acute Appendicitis

- Appendicitis is the **most common acute condition** of the **abdomen** requiring surgery\(^1\)
- Incidence in North America \(\approx 1\) in 400\(^2\)
- The overall frequency of appendicitis for symptomatic patients is between **41%** (<20 yrs old)-**59%** (>20 yrs old)\(^3\)
- Classified as a **medical emergency** due to an increased risk of **septic shock, peritonitis** and **damage to intra-abdominal organs**\(^4\)

CT: Imaging Modality of Choice

- At Foothills Medical Centre, with an **Alvarado score** between 4-7, an imaging test is performed, either CT or ultrasound.
- **CT** is a **more accurate test** than ultrasound, with a 95% sensitivity and 95%-100% specificity, **reduces the false-negative appendectomy rate without an increase in the rate of appendix perforation**.
- **Most widely used protocol** for imaging abdomen to diagnose acute appendicitis is to administer both **positive Oral and IV contrast media** and scan using a **standard-radiation-dose CT technique**.

---

Drawbacks of Using Oral Contrast

• Despite allowing 1 to 3 hours between oral contrast intake and scanning, the oral contrast material **fails to reach the cecum in 18 to 30%** of the patients\(^8\)
• **1 to 3 hour** time-period also **prolongs the patient-stay** the in EDs and results in delayed diagnosis
• **Delays in operative intervention** have been shown to potentially increase the chance of rupture\(^9\)
• **Drinking Oral contrast** **increases patient discomfort** and increases the **risk of aspiration** as patients often present with nausea and vomiting

---


Different Protocols for Acute Appendicitis

- Multiple variations of contrast administration have been published: IV\textsuperscript{10}, Oral\textsuperscript{11} or Rectal\textsuperscript{12} contrast material alone, “Triple” contrast (IV, Oral and rectal)\textsuperscript{13}, or completely unenhanced\textsuperscript{14}

- IV contrast enhanced CT with or without Oral contrast material demonstrate similar sensitivity, specificity, positive predictive value or negative predictive value\textsuperscript{15, 16}

- The interpretation of individual readers favors Oral contrast administration\textsuperscript{16}

\textsuperscript{12} Rao PM, et al. Helical CT combined with contrast material administered only through the colon for imaging of suspected appendicitis. AJR Am J Roentgenol 1997; 169:1275-1280.
\textsuperscript{15} Keyzer C, et al. AJR Am J Roentgenol 2009; 193:1272-1281
Objectives

To compare the radiologist’s ability to

- Visualize the appendix and periappendiceal secondary signs of inflammation
- Diagnose acute appendicitis
- Diagnose alternative pathologies responsible for acute abdominal pain

amongst three groups of adult patients undergoing CT scan: IV contrast-only; IV and Oral contrast with 1 hr transit time; IV and Oral contrast with 3 hr transit time.
Study Design

Randomly selected 75 patients presenting to ED due to Trauma

Patients with previous appendectomies were excluded from the study

CT scans with IV Contrast only (n=69)

Randomly selected 150 patients presenting with query appendicitis

CT scans with IV + oral contrast for 1 hr* (n=73)

CT scans with IV + oral contrast for 3 hrs* (73)

Images were interpreted by three radiologists** for diagnosing Appendicitis and assessing the reader confidence of visualizing the appendix

Results from analyzing CT scans from three groups were compared to each other

Results were compared to the surgery and pathology reports

Chart reviews were carried out to determine Surgical and Pathology reports, which were used as gold standards for the diagnosis of Acute Appendicitis

<table>
<thead>
<tr>
<th>Appendicitis (+)</th>
<th>Appendicitis (-)</th>
</tr>
</thead>
<tbody>
<tr>
<td>True Positive</td>
<td>False Negative</td>
</tr>
<tr>
<td>False Positive</td>
<td>True Negative</td>
</tr>
</tbody>
</table>

ED = Emergency Department, *Time between drinking oral contrast and performing CT, **3 radiologists = 1 staff, 1 fellow, and 1 resident radiologist
Scoring System

Visualization of Appendix
Appendix Visualized = 1
Appendix Not Visualized = 0

Factors determining the diagnosis of Appendicitis
- Luminal Distention
- Mucosal Hyperenhancement
- Mesenteric Hyperemia
- Mesenteric Lymph Nodes
- Periappendiceal Inflammatory stranding
- Evidence of Perforation
- Appendicolith
- Lymph Nodes

Overall Assessment of Appendicitis
- 5 = Definitely Appendicitis
- 4 = Probably Appendicitis
- 3 = Unsure about Appendicitis
- 2 = Probably not Appendicitis
- 1 = Definitely not Appendicitis
IV Contrast only vs IV and Oral Contrast enhanced scans
Frequency of Visualizing Appendix Improves with the Addition of Oral Contrast

![Bar chart showing the frequency of visualizing the appendix with different conditions. The chart compares IV Only, Oral + IV_1hr, and Oral + IV_3hr, with the frequency of visualization increasing from IV Only to Oral + IV_3hr.](chart_image)
Difficult to See a Normal Appendix
Amongst Non-opacified Bowel Loops

Normal Appendix
Oral Contrast Aids in Visualizing Appendix

Oral was really useful

Oral would have been useful

Inflamed appendix
1hr and 3hr Protocols have similar Diagnostic Performance

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity (95%CI)</th>
<th>Specificity (95%CI)</th>
<th>Accuracy</th>
<th>Positive Predictive Value (95%CI)</th>
<th>Negative Predictive Value (95%CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV+Oral Contrast (1hr)</td>
<td>100 (85.4-100)</td>
<td>97.67 (86.2-99.8)</td>
<td>98.61</td>
<td>96.67 (80.9-99.8)</td>
<td>100 (89.6-100)</td>
</tr>
<tr>
<td>IV+Oral Contrast (3hr)</td>
<td>100 (85.4-100)</td>
<td>97.72 (86.9-99.8)</td>
<td>98.63</td>
<td>96.67 (80.9-99.8)</td>
<td>100 (89.8-100)</td>
</tr>
<tr>
<td>IV Contrast Only</td>
<td>ND</td>
<td>100 (93.4-100)</td>
<td>100</td>
<td>ND</td>
<td>100 (93.4-100)</td>
</tr>
</tbody>
</table>
# Alternative Diagnosis

<table>
<thead>
<tr>
<th></th>
<th>IV and Oral 1hr</th>
<th>IV and Oral 3hr</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acute Appendicitis, n (%)</strong></td>
<td>29 (40.2%)</td>
<td>29 (39.7%)</td>
</tr>
<tr>
<td><strong>GI, n (%)</strong></td>
<td>8 (11.1%)</td>
<td>5 (6.8%)</td>
</tr>
<tr>
<td><strong>GU, n (%)</strong></td>
<td>2 (2.8%)</td>
<td>3 (4.1%)</td>
</tr>
<tr>
<td><strong>Gyn, n (%)</strong></td>
<td>3 (4.2%)</td>
<td>4 (5.4%)</td>
</tr>
<tr>
<td><strong>Other, n (%)</strong></td>
<td>0</td>
<td>3 (4.1%)</td>
</tr>
<tr>
<td><strong>Negative, n (%)</strong></td>
<td>30 (41.2%)</td>
<td>32 (43.8%)</td>
</tr>
</tbody>
</table>
Oral Contrast Shows Intussusception

Intussusception
CONCLUSION

• Reader confidence in visualizing the appendix is:
  ➢ **Superior** with the **addition of oral contrast as compared to IV contrast alone**
  ➢ **1 hour Oral** regimen is not inferior to the **3 hour Oral** regimen

• **1 hour and 3 hour** oral regimens have a **similar diagnostic performance in diagnosing appendicitis**

• Administering oral contrast **helps with diagnosis of alternative pathologies**
ACKNOWLEDGMENTS

Department of Radiology, University of Calgary
Dr. Lancia Guo, MD
Dr. Hein Els, MD
Dr. Deepak Bhayana, MD

Department of Emergency Medicine, University of Calgary
Dr. Erik J Saude, MD/PhD
Dr. Eddie Lang, MD
Dr. Andrew McRae, MD/PhD