

# Acute Abdominal Pain: MDCT Protocol Considerations

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## Acute Abdominal Pain

- **“Acute Abdomen”:**
  - Clinical syndrome
  - Severe abdominal pain
  - Requires immediate medical or surgical therapy
  - Differential diagnosis: large number of conditions, some even extra-abdominal

## Acute Abdomen

- Often difficult diagnostic dilemma
- Clinical presentation, physical examination can be very nonspecific
- Laboratory exams: non-diagnostic or not specific
- Imaging: very useful, cornerstone of evaluation
  - KUB (plain radiograph): free gas
  - Ultrasonography: gallbladder, biliary ductal system, appendix in some patients

## Computed Tomography

- Has become preferred method, global information:
  - Bowel
  - Mesentery
  - Omentum
  - Peritoneum
  - Retroperitoneum
- Not limited by gas or fat

## Causes of Acute Abdomen

- Bombal et al (1991), 30.000 patients:
  - 28% Acute appendicitis
  - 10% Acute cholecystitis
  - 4% Bowel obstruction
  - 4% Gynecologic diseases
  - 3% Acute pancreatitis
  - 3% Renal colic
  - 2% Perforated duodenal ulcer
  - 2% Acute diverticulitis
  - **33% Unknown cause**

## CT: Impact

- Specific diagnosis in the vast majority of patients
- Localizes focus of the symptoms with great certainty
- Focuses differential diagnosis
- Decreases number of patients without diagnosis
- Decreases unnecessary admissions
- Decreases time of observation
- Timely surgical management when indicated o

## 64MDCT Protocols

- 1.25 mm?
- What about isotropic voxels?
- Trade-off for decreased radiation dose
- Subjectively negligible difference in MPR quality
- Data can be “unfused” to 0.625mm- noisy, but may be helpful

## 64MDCT Protocols

- Direct MPR function generates coronal and sagittal reformations in all cases
- 2.5mm slice thickness
- Coronal reformations, along with transverse images improved confidence in visualization of appendix and diagnosing or excluding appendicitis

## 64MDCT Protocols

- Small bowel obstruction; coronal reformations helped to increase reader confidence in diagnosing or excluding small bowel obstruction
- 64MDCT acute abdomen; improved diagnostic confidence and inter-observer agreement

## Oral Contrast?

## Positive Oral Contrast Success

- Appendicitis, sensitivity and specificity; 99% and 95%, respectively (4MDCT)
- Diverticulitis, sensitivity 93% (single detector) vs barium enema 80%
- Diverticulitis with rectal contrast, sensitivity and specificity, 97% and 100%, respectively (single detector)

## 64MDCT: Do we still need oral contrast?

- Decreasing acquisition times serve to “freeze” the bowel and limit motion artifact secondary to peristalsis
- Must be able to evaluate thickness of the bowel wall

## Evaluating Bowel Wall Thickness

- Previously, oral contrast clearly delineated bowel wall thickness
- Currently, clear visualization of enhancing bowel wall mucosa serves to illuminate thickness

## Bowel Enhancement

- Evaluation of peak small bowel mucosal enhancement
- Arterial, enteric (peak mucosal), and portal venous phases
- Peak small bowel enhancement 49 seconds
- Statistically significant differences between small bowel conspicuity on arterial vs enteric but not enteric vs portal venous

## The Case for Intravenous Contrast

- Appendicitis
- Comparison of focused CT + oral, without IV vs nonfocused imaging with IV + oral
- Sensitivities for focused imaging without oral contrast ranged from 71-83%
- Sensitivities for IV + oral ranged from 88-93%
- Stated primary difference was in increased visualization given enhancing appendiceal mucosa

## Reconsidering Oral Contrast

- Boston University experience
- Controlled, 2 hour preparatory time, 900mL oral contrast
- Distal most location of contrast opacification identified
- No portion of the colon opacified in 30%
- Distal colon opacified in only 35%

## Reconsidering Oral Contrast

- Standard one hour preparatory time
- Two different positive oral contrast agents
- 900mL barium sulfate 2% w/w
- 465mL iohexol 0.2% w/w
- Colon opacified in < 50% patients in both groups

## Impact of Oral Agent

- 1,600ml of water-iodinated contrast mixture with 2-2.5 hour delay vs 1,000ml PEG-iodinated contrast mixture with 1 hour delay
- 18/40 water-iodine opacified cecum
- 38/40 PEG-iodine opacified cecum

## Literature thus far

- 118 patients with abdominal pain imaged both with and without oral contrast (no IV contrast)
- Concluded that imaging should be considered without oral contrast given 79% simple agreement
- One patient with discordant consensus evaluation

## Literature thus far

- Retrospective review of 173 patients imaged with intravenous contrast, no oral contrast
- Evaluated detection of appendicitis
- Sensitivity, 100%
- Specificity, 97%

## How does oral contrast help?

- Appendicitis
- Oral contrast does not reliably fill the appendiceal lumen in normal patients
- Lack of filling with oral contrast is not helpful in diagnosing appendicitis
- 61% filled with oral contrast; (44%) or oral contrast and air (17%)

## How does oral contrast help?

- Most useful individual findings in acute appendicitis: enlarged appendix, appendiceal wall thickening, periappendiceal fat stranding, and appendiceal wall enhancement
- Oral contrast unlikely to increase conspicuity of these findings

## How does oral contrast help?

- Diverticulitis
- Provides reliable assessment of the thickness of the bowel wall
- Evaluation of thickness critical in making this diagnosis on CT
- Diagnostic accuracy of this single finding: sensitivity 96%, specificity 91%

## How does oral contrast help?

- Small bowel obstruction
- The use of oral contrast in CT protocols for suspected SBO vary widely
- May demonstrate function depending on the transit of positive oral contrast during the preparatory time

## \*Small Bowel Obstruction

- As ischemia is a potential complication, we prefer to evaluate suspected SBO without the use of oral contrast
- Evaluating degree of mucosal enhancement limited with the use of positive oral contrast

## \*Small Bowel Obstruction

- 126 patients with acute abdominal pain and mural thickening of small bowel
- Those without inner layer enhancement demonstrated significantly increased rates of requiring operative management, bowel resection, having necrosis, and death

## Boston University Experience

- Prospective, randomized trial
- 303 patients enrolled
- Patients with non-traumatic abdominal pain suspected of having appendicitis, diverticulitis, or small bowel obstruction
- Randomized to two groups: oral and intravenous contrast or sole use of intravenous contrast

## Protocols

- 1.25mm slice thickness
- Dual syringe power injector
- 100mL intravenous contrast, 4mL/sec followed by 30mL saline chaser, 4mL/sec
- 70 second delay
- Direct MPR
- Oral contrast: 900mL barium sulfate 2% w/w
- 2 hour standard preparatory time

## Image analysis

- Three expert emergency radiologists
- Each CT scan evaluated by 2 radiologists
- Assessing for appendicitis, diverticulitis, and SBO
- If no consensus between two reviewers assigned a case, third reviewer asked to evaluate
- Axial, MPR, other post-processing options available

## Standards of reference

- Clinical outcomes including operative and pathology reports evaluated and used as standard of reference
- Expert CT reads compared with clinical outcomes to determine diagnostic accuracies

## Appendicitis

- Three patients excluded from each group
- Oral + IV Group: 14 patients with appendicitis, sensitivity and specificity; 100% and 98.5%, respectively
- IV Group: 13 patients with appendicitis, sensitivity and specificity; 100% and 98.5%, respectively

## Diverticulitis

- Oral and IV Group: 11 patients with diverticulitis, sensitivity and specificity; 91% and 99% respectively
- IV Group: 10 patients with diverticulitis; 90% and 97%, respectively

## Small Bowel Obstruction

- Oral and IV Group: 4 patients with small bowel obstruction, sensitivity and specificity; 25% and 100%, respectively
- IV Group: 7 patients with small bowel obstruction, sensitivity and specificity; 100% and 99%, respectively

## Overall Performance

- Oral and IV Group: sensitivity and specificity; 86% and 96% respectively
- IV Group: sensitivity and specificity; 93% and 93%, respectively
- No statistically significant difference
- 80% power to detect difference in sensitivity or specificity of 90% vs 70%

## BMI Considerations

- 100 patients imaged both with and without oral contrast (no IV contrast)
- No association between BMI or waist circumference

## BMI Considerations

- 94 patients with suspected appendicitis; comparison of US and NECT
- No statistically significant differences in diagnostic accuracy of NECT for the diagnosis of appendicitis based on differences in BMI

## BMI Considerations

- Increased degree of visceral fat often provides separation and increased visualization of bowel loops
- Area deserves further research
- ? Individually tailored protocols for abdominal pain based on BMI

## Clinical Impact

- 183 patients, 102 NECT, 81 CECT
- Significant differences in arrival time to physician evaluation (57 vs 84 min), time of CT order to scan time (104 vs 172 min), ED arrival time to disposition (358 vs 599 min)
- Differences seen to be greater than time allotted for oral preparation

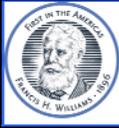
## Clinical Impact

- 112 patients, rectal contrast and oral contrast arms in patients with suspected appendicitis
- Length of stay decreased significantly (261 vs 332 min)

## Conclusion

- 64MDCT offers a significant advance in the application of abdominal pain imaging
- Allows reconsideration of the necessity of oral contrast
- Early work demonstrates no significant difference in diagnostic accuracy; further work is called for

Thank you.



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