Dual Energy and Low kV Techniques: Impact On Oral Contrast Density At Helical CT

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DISCLOSURES

NONE
Background

• Positive oral contrast, both barium and iodine based, has been formulated for optimal opacification (200HU) of the gastrointestinal tract when imaged using traditional 120 kV single energy techniques.

• These oral contrast concentrations may not be optimized for newer low kV and dual energy CT acquisitions which increase relative densities of contrast media.
The purpose of this study was to assess the quantitative and qualitative effects of kV on oral contrast density using single and Dual Energy CT techniques.
Methods

Phantom Study

A commercially available CIRS tissue equivalent phantom was utilized to image oral contrast materials using kV settings ranging from 80-140 kV single-energy and 90 and 150 kV dual-energy CT techniques on a second generation dual source CT scanner.

Both non-dilute barium sulfate suspension (Readi-CAT2, Bracco, Princeton, NJ) and a range of iodine-based oral contrast dilutions (Iohexol, GE Healthcare, Chicago, IL) were assessed.
Methods

Retrospective Study

Additionally, a retrospective analysis of 32 consecutive oral contrast enhanced CT scans in 21 patients was performed. Scans were performed on a variety of single and dual energy CT scanners employing a range of kV settings from 90-150. Both oral contrast density and reader-determined optimal bowel window and level (W/L) settings were retrospectively, independently assessed by 3 fellowship trained abdominal imagers.
Results
Phantom Study

• Barium sulfate and iohexol solutions corresponding to those used in clinical practice showed a range of CT densities for relevant kV settings of between 207 and 598 HU.

• For lower energy techniques (90-110 kV), an iodine concentration of between 5.82 and 7.77 mgI/mL most closely approximated an oral contrast density of 200 HU.

• Lower kV settings resulted in higher oral contrast densities on single energy (SE) and dual energy (DE) techniques across all contrast dilutions (following graph*)

*DE measurements include individual tube reconstructions (low energy (90) and high energy (150)) as well as blended and monoPLUS (50kEv) dual energy reconstructions
Oral contrast density versus kV

% Stock Solution (g/l/mL solution)
- 100 (19.4)
- 90 (17.5)
- 80 (15.6)
- 70 (13.6)
- 60 (11.7)
- 50 (9.7)
- 40 (7.8)
- 30 (5.8)
- 20 (3.9)
- 10 (1.9)
- Barium
Results

Retrospective study

• Using both single and dual energy techniques, average oral contrast density ranged from 267.8 HU to 419.9 HU.

• 77% of cases required window and level adjustment, with readers choosing 2.8 and 2.7 times higher window and level settings compared to conventional abdominal window settings (350/50).
Oral contrast density ranges from 90 HU (150kV) to 215 HU (100kV) on CT reconstructions performed on the same dual source DECT acquisition.
Iodine and barium oral contrast materials had optimal 200 HU only when 120 kV (SE) or high kV reconstructions (DE) were utilized.
### Reader Window and Level Preference

<table>
<thead>
<tr>
<th></th>
<th>Window</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard ABD W/L</td>
<td>350</td>
<td>50</td>
</tr>
<tr>
<td>Reader 1</td>
<td>666</td>
<td>149</td>
</tr>
<tr>
<td>Reader 2</td>
<td>992</td>
<td>179</td>
</tr>
<tr>
<td>Reader 3</td>
<td>1277</td>
<td>74</td>
</tr>
<tr>
<td>Average W/L</td>
<td>976</td>
<td>133</td>
</tr>
</tbody>
</table>

77% of cases required window and level adjustment, with readers choosing 2.8 and 2.7 times higher window and level settings, respectively compared to conventional abdominal window settings (350/50).
Results

Retrospective study

• In the retrospective patient study, overall single and dual energy techniques, average oral contrast density ranged from 267.8 HU in the jejunum to 419.9 HU in the ileum.

• All three readers uniformly preferred high kV images for assessment of the bowel at Dual Energy CT when images were displayed at default 350/50 abdominal window settings.
Conclusion

• Oral contrast HU density is strongly influenced by kV settings at both single and dual energy CT.
• Increasing dilution of iodine-based oral contrast material may be possible when using lower kV techniques.
• For lower energy techniques (90-110 kV), an iodine concentration of between 5.82 and 7.77mgI/mL most closely approximates a targeted oral contrast density of 200HU.