Assessment of Stone Volume in VNC Images: Do small stones disappear?

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DISCLOSURES

Research Support:

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<tr>
<th>NIH</th>
<th>Other</th>
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<td>Mayo Discovery Translation Award</td>
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<td>RR 018898</td>
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Off Label Usage
None
**Background**

- Virtual Non Contrast (VNC) images may allow for the detection and characterization of urinary stones using contrast enhanced exams. This might eliminate the need for an unenhanced scan in CT urography, therefore reducing dose to the patient.

- However, previous studies noted a decrease in stone volume using VNC images, making small stones undetectable.

(Wang, 2012; Takahashi, 2008; Takahashi, 2010)
**Purpose**

- Evaluate the accuracy with which VNC images can characterize the size and volume of urinary stones
  - Phantom study
  - Newer dual-source CT scanner model

**Purpose**

Unenhanced = VNC
Methods and Materials

• 64 Stones: 32 Uric Acid (UA) and 32 Non-UA
  – purity >90%
  – embedded in gelatin
  – submerged in 35 and 40 cm wide water phantoms
  – scanned on the Siemens Somatom Force using clinical protocol for urinary stone quantification

• 120 kV
• 70 – Sn150 kV
• 80 – Sn150 kV
• 90 – Sn150 kV
• 100 – Sn150 kV

Methods and Materials

• 240 quality reference mAs, 120 kV
  – CTDIvol for 35cm = 16 mGy
  – CTDIvol for 40cm = 26 mGy

• Images reconstructed using medium sharp kernel (Qr44), 20cm FOV, 1 mm image width, 0.8 mm interval

• Scanned first in gelatin only

• Scans repeated after gelatin replaced with contrast enhanced gelatin of ~20mgI/ml (400 HU @120kV).
**Methods and Materials**

- VNC images created using Siemens Syngo VIA (version VA30) “Virtual Unenhanced” application
- Stone size measured using the width of a 3D box enclosing the stone
- Stone volume measured using an adaptive threshold based method
- Both measurements done using in-house software
- Bland-Altman analysis and paired t-test used to assess the accuracy of stone size and volume in VNC compared to the 120 kV unenhanced scan.

**Results: Metrics from unenhanced 120kV**

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<tr>
<th>Metric</th>
<th>Mean</th>
<th>Max</th>
<th>Min</th>
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<tbody>
<tr>
<td>Length [mm]</td>
<td>5.58</td>
<td>11.32</td>
<td>3.15</td>
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<tr>
<td>Width [mm]</td>
<td>4.24</td>
<td>8.86</td>
<td>2.28</td>
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<tr>
<td>Height [mm]</td>
<td>3.00</td>
<td>4.99</td>
<td>1.66</td>
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<tr>
<td>Maximum dimension [mm]</td>
<td>5.74</td>
<td>11.6</td>
<td>3.25</td>
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<tr>
<td>Volume [mm³]</td>
<td>44.95</td>
<td>196.17</td>
<td>9.03</td>
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*5 out of 64 stones were excluded from the study because either they had a low density core or were surrounded by air bubbles*
Results

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<tr>
<th>Unenhanced</th>
<th>NUA</th>
<th>VNC</th>
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35 cm wide phantom: Stone Size

Unenhanced (120 kV) vs VNC (90-Sn150 kV)

Axial Pixel Size: 0.39 mm, increment 0.8 mm

P > 0.05
Unenhanced (120 kV) vs VNC (90-Sn150 kV)
35 cm wide phantom: Stone Volume (mm$^3$)

Unenhanced (120 kV) vs VNC (90-Sn150 kV)
35 cm wide phantom: Volume (%)
Results

- No statistically significant difference in stone volume measured in VNC images compared to unenhanced scan*
  - Except for the 70-Sn150 kV scan (noise and dose issues)
- Stone composition had a significant effect on the volume difference (P<0.01) between unenhanced and VNC images.
- Average difference in stone volume was ± 10.4% and ± 9.4% for stone size over all kV combinations and both phantom sizes.

*For relatively small stones and the amount of iodine enhancement used in this study

Conclusions

- For the evaluated scanner, with increased spatial resolution and spectral separation, urinary stone volume and size can be accurately quantified in a contrast-enhanced scan using VNC images created from a DECT data set*
- VNC images may now have sufficient quality to eliminate the unenhanced phase in CT urography, therefore reducing dose to the patient
- Further testing in vivo is warranted

*For relatively small stones and the amount of iodine enhancement used in this study