Dual Energy CT: Renal Stones

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DECT: Renal Stones

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Disclosures

None
Outline

- DECT applications for renal stones
  - Detection
  - Detection on excretory phase imaging
  - Stone composition characterization
Renal Stones in MDCT

Clinical Relevance:
- Growing prevalence
- 7% men
- 12% women
- Composition determines treatment
Kidney Stones rise due to Global Warming
60 yo man with flank pain
Dual Energy (80/140 kVp)

Virtual Non Contrast (VNC)

The vertical line in the liver represents the lateral border of the 80 kV tube.
How about added Dose with DECT

<table>
<thead>
<tr>
<th>Effective Dose (mSv)</th>
<th>Single-Energy Unenhanced Scan</th>
<th>Dual-Energy Enhanced Scan</th>
<th>Single-Energy Dual Phase&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>1.47</td>
<td>4.21</td>
<td>2.93</td>
</tr>
<tr>
<td>Maximum</td>
<td>8.46</td>
<td>10.26</td>
<td>16.93</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
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</tbody>
</table>

<sup>a</sup>Estimated by multiplying the dose of single-energy unenhanced scan by factor of 2.

Kaza R, Caoili E, Cohan R, Platt R AJR 2011
Urinary Stone Composition

- Elusive using traditional imaging techniques
- Operative extraction invasive, time consuming, expensive
- Enables medical and interventional management
Who cares?

- Uric acid: alkalanize urine
- Differentiate CO monohydrate, CO dehydrate, CA phosphate:
  - COM endoscopic retrieval (hard stones)
  - COD/CAP ESWL (soft stones)
- Struvite/ Cystine: blood tests, urine testing, initiate medical treatment
- Brushite: endoscopic retrieval (super hard)
- Analysis of tiny stones
Prior approach

- Sequential CT at various energy levels
  - Time consuming
  - Radiation issues
  - Mis-registration artifact

- Current generation DECT overcomes many of these problems
Noninvasive Differentiation of Uric Acid versus Non-Uric Acid Kidney Stones Using Dual-Energy CT

Andrew N. Primak, Joel G. Fletcher, Terri J. Vrtiska, Oleksandr P. Dzyubak, John C. Lieszke, Molly E. Jackson, James C. Williams, Jr, Cynthia H. McCollough

- 40 human stones porcine/cadaver spine phantom
- DECT (Somatom Definition)
- Uric acid vs non-uric acid
- Uric acid stones (contain H, C, N, O) vs Ca
- Ca higher attenuation at lower kVp
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Figure 2. A simplified description of how the DE algorithm works. If a datapoint corresponding to a stone with unknown composition falls below the bisector line (dashed) dividing the angle between the uric acid (UA) and non-UA line segments, the algorithm will characterize such stone as a UA stone (open circle). If an unknown datapoint falls above the angle bisector line, the corresponding stone will be identified as a non-UA stone (gray circle).
Renal Stone Assessment with Dual-Energy Multidetector CT and Advanced Postprocessing Techniques: Improved Characterization of Renal Stone Composition—Pilot Study

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In-Vitro Renal Stones in DECT

Boll DT, et al. Assessment of renal stones employing Dual Energy MDCT with advanced Postprocessing Techniques: Improved Characterization of Stone Composition Radiology. 250(3); 2009
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In Vivo Determination of Urinary Stone Composition Using Dual Energy Computerized Tomography With Advanced Post-Acquisition Processing


From the Comprehensive Kidney Stone Center (DEZ, MNF, GMP, MEL) and the Department of Radiology (EKP, DTB), Duke University Medical Center, Durham, North Carolina

- 25 pts, June 2008-July 2009
- DE MDCT (Somatom, Definition)
  - Pitch: 0.55
  - Gantry rotation: 0.5 sec
  - Collimation 1.2 mm
  - 140 kVp / 118mAs
  - 80kVp / 499 mAs
- 82 stones extracted and analyzed
In-Vivo Renal Stones in DECT

Renal Stone Differentiation based on post-processed Slope Series

Composition with minor Admixtures (≤70% pure)  Composition with major Admixtures (≤70% pure)
DECT with advanced post processing for stone composition

- Straight forward for uric acid vs other
- Feasible for determination of other stone classes
  - Drives surgical, interventional, medical approaches
- Analysis software increasingly available
- Non-invasive stone analysis approach obviates:
  - Urine analysis /straining
  - Blood tests
  - Stone extraction
Virtual non-contrast potentially eliminates true non-contrast images
Permits identification of stones in excretory phase
Non-invasive stone analysis approach obviates:
- Urine analysis /straining
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- Stone extraction
THANK-YOU