AUA Guidelines for Imaging Known or Suspected Ureteral Calculi

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Duke University Medical Center
Imaging for Urolithiasis

- Justification for the Guidelines
- Current Imaging Modalities
- AUA Guidelines on the Imaging of Ureteral Calculi
- Novel Imaging Techniques
Clinical Effectiveness Justification

Clinical management per existing guidelines

Consideration of performance characteristics of imaging modality

Clinical effectiveness decision-tree diagrams integrate performance characteristics, risks and costs
Imaging Guidelines
Panel Considerations

• Evaluated current imaging modalities for:
  – Diagnostic accuracy for identifying ureteral calculi and/or hydronephrosis
  – Risks to patient - i.e. radiation exposure
  – Cost

• Guidelines set out to balance these factors to come up with decision trees
• Computed Tomography (CT)
• Ultrasound (US)
• Plain abdominal radiography (KUB)
• Intravenous pyelograms (IVP)
• Magnetic Resonance Imaging (MRI)
# Imaging For Stones

## Sensitivity and Specificity

<table>
<thead>
<tr>
<th>Imaging Technique</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-contrast Computed Tomography</td>
<td>95%-98%</td>
<td>96%-98%</td>
</tr>
<tr>
<td>“Low Dose” CT</td>
<td>97%</td>
<td>95%</td>
</tr>
<tr>
<td>Ultrasound</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Renal stones</td>
<td>29%-81%</td>
<td>82%-90%</td>
</tr>
<tr>
<td>Ureteral Stones</td>
<td>11%-93%</td>
<td>87%-100%</td>
</tr>
<tr>
<td>Plain Radiography</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KUB</td>
<td>45%-58%</td>
<td>69%-77%</td>
</tr>
<tr>
<td>IVP</td>
<td>85.2%</td>
<td>90.4%</td>
</tr>
<tr>
<td>Magnetic Resonance Imaging</td>
<td>93%-100%</td>
<td>95%-100%</td>
</tr>
</tbody>
</table>

Lipkin ME, Preminger GM. Clinical Urolithiasis 2012
Radiation Exposure

F.D.A. to Investigate Risks of Medical Radiation

February 10, 2010

The New York Times

By WALT BOGDANICH

The federal Food and Drug Administration said on Tuesday it would more stringently regulate medical radiation, including increased testing of radiation-emitting materials. The FDA recently said that Americans get the most medical radiation exposure of any developed nation.

FDA aims to reduce medical radiation exposure

Safety controls will be required on CT scanners to prevent excessive doses
Increasing CT scans

Brenner DJ and Hall EJ, NEJM 2007
Future Cancers from 2007 CT

Estimated 29,000 Cancers related to CT scans performed in 2007

Berrington de Gonzales et al., Arch Int Med, 2009
Effective Dose

Renal ultrasound and MRI have no radiation exposure

Low Dose CT

Meta-analysis

- Meta-analysis of 7 studies evaluating NCCT with dose < 3 mSv (low dose)
- Compared to standard dose CT (~10-12 mSv)
  - Pooled sensitivity 97% (95-98%)
  - Pooled specificity 95% (92-97%)

Nieman et al AJR 2008
### Low Dose CT

#### Obesity

- Sensitivity and specificity for detecting ureteral stone affected by BMI:

<table>
<thead>
<tr>
<th></th>
<th>BMI &lt; 30</th>
<th>BMI &gt; 30</th>
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</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>95%</td>
<td>50%</td>
</tr>
<tr>
<td>Specificity</td>
<td>97%</td>
<td>89%</td>
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</table>

Poletti et al AJR 2007
# Imaging For Stones

<table>
<thead>
<tr>
<th></th>
<th>Diagnostic Accuracy</th>
<th>Time to perform exam</th>
<th>Radiation Exposure</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCCT</td>
<td>+++</td>
<td>+++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Low dose NCCT</td>
<td>+++</td>
<td>+++</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Ultrasound</td>
<td>++</td>
<td>++</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>KUB</td>
<td>+</td>
<td>+++</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>IVP</td>
<td>++</td>
<td>+</td>
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<td>++</td>
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<tr>
<td>MRI</td>
<td>++</td>
<td>+</td>
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Clinical Effectiveness

Decision Tree Diagrams

Specifically addresses imaging

Initial presentation
Observation / medical expulsive therapy
Follow up imaging after treatment
AUA Guidelines
Imaging Ureteral Stone
Initial Presentation
Abdominal/Flank Pain
BMI < 30 kg/m²
Yes
Low Dose NCCT
KUB if stone not visible on CT Scout
No
Standard Protocol NCCT
Follow up after observation ± medical expulsive therapy
Radio-opaque Stone

Symptomatic

Yes

Renal Sono/KUB

No

Passed Stone

Yes

No Imaging

No

Renal Sono/KUB
Non radio-opaque Stone

Symptomatic

Yes

NCCT

No

Passed Stone

Yes

No Imaging

No

NCCT
Follow up after shock wave lithotripsy (SWL)
Post-SWL

Radio-opaque Stone

Yes
Renal Sono/KUB

No
Renal Sono

Hydro

Yes
NCCT

No
Imaging if symptoms
Follow up after ureteroscopy
Intact Stone Removal

Symptomatic

Yes

CT Abdomen/Pelvis with Contrast

No

Renal sono

Hydro

Yes

CT Abdomen/Pelvis with Contrast

No

No Further Imaging
Post-fragmentation

Symptomatic

Radio-opaque

Yes

Renal Sono/KUB

No

Low Dose NCCT
Asymptomatic

Post-fragmentation

- Radio-opaque
  - Yes: Renal Sono/KUB
  - No: Renal Sono
    - Hydro
    - Low Dose NCCT
Imaging For Stones

Ideal study would:

• High sensitivity and specificity
• Minimal or no radiation exposure
• Low cost
• Quickly performed
Imaging For Stones

New Imaging Techniques

Digital Tomosynthesis (DT)
Digital Tomosynthesis

- Acquire a series of projections during a single sweep of the X-ray tube over limited angle
- Software reformats to provide several high resolution “slice” images at different depths
- Removes overlying structures
Digital Tomosynthesis

Requires digital flat panel detector and image reconstruction software
Ureteral Stone
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Digital Tomosynthesis
Radiation Exposure

<table>
<thead>
<tr>
<th></th>
<th>KUB w/ Tomograms</th>
<th>Digital Tomosynthesis</th>
<th>Renal Stone CT</th>
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<tbody>
<tr>
<td>Effective Dose (mSv)</td>
<td>3.93</td>
<td>0.85</td>
<td>3.04</td>
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Standard KUB dose ranges from 0.3-0.6 mSv

Digital tomosynthesis shows promise for the detection and follow up of renal stones.

<table>
<thead>
<tr>
<th></th>
<th>Kidney Stones</th>
<th>Ureteral Stones</th>
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<tbody>
<tr>
<td>Digital Radiography</td>
<td>24%</td>
<td>38%</td>
</tr>
<tr>
<td>Digital Tomosynthesis</td>
<td>66%</td>
<td>29%</td>
</tr>
</tbody>
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Mermuys K, et al. AJR 2010
Conclusion

• Non-contrast CT is still the gold standard imaging study for the evaluation of urolithiasis

• Low-dose protocol NCCT should be first line imaging study in non-obese patients
Renal sono/KUB still play large role in the imaging of ureteral stone and should be used when clinically indicated.

Digital tomosynthesis may help improve sensitivity/specificity of KUB with minimal increase in radiation.