Screening and Management of Asymptomatic Renal Stones in Astronauts

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Disclaimer

• No off label uses

• No conflicts of interest
Overview

• Anatomy and pathology
• Epidemiology
• Screening
• Management
• Waiver
kidney with moderate hydronephrosis
General Population

• Lifetime prevalence 10% male, 5% female
  ▪ Increasing incidence (20 - 74 y.o.)
• 3.7% to 4.6% of commercial aviation pilots \(^2\)

Mineralized Renal Material (MRM)

- Small areas of calcification found incidentally
- Of uncertain significance
- We need to characterize MRM
  - How common?
  - Do they turn into stones or disappear with time?
  - Is spaceflight a risk factor for clinical stones?
Screening Needs

• Management of MRM/stone has varied widely

• Unknown how many astronauts have MRM

• Understanding is important for future missions
Screening Needs

- Periodic screening → Annual exams
- Low or no radiation → Ultrasound
- Standardized methodology → Ultrasound review panel
- Standardized management → A clinical practice guideline
When to Screen?

- **All Active Astronauts**: Annual Ultrasound
- **History of Renal Stone**: Annual Ultrasound and Labs
- **SFTL**: Ultrasound L - 6 Months
- **Post-Flight**: Ultrasound R +1 Month

See Management Matrix
Ultrasound Benefits

• Low cost

• No radiation

• Easy to do

• Easy to repeat

• Minimal time commitment for astronauts
## Natural History

<table>
<thead>
<tr>
<th>Size (mm)</th>
<th>Stone Free</th>
<th>Progression</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;= 5</td>
<td>28%</td>
<td>40.4%</td>
<td>5.3%</td>
</tr>
<tr>
<td>5 - 10</td>
<td>4.8%</td>
<td>52.4%</td>
<td>9.5%</td>
</tr>
<tr>
<td>&gt;= 10</td>
<td>0%</td>
<td>71.4%</td>
<td>14.3%</td>
</tr>
</tbody>
</table>

Spontaneous Passage vs. Stone Size

Ueno et al. (1977), Relation of spontaneous passage of ureteral calculi to size, Urology, 10(6):544-546
Enhanced U/S Protocol

1. **Echogenic** → seen from 2 or more angles

2. **Shadowing** → opaque to ultrasound

3. **Twinkling** → twinkling in Doppler mode

4. **Dispersion** → spectral frequency dispersion

5. **Measurable** → >3 mm

6. **Location** → parenchymal, papillary or collecting system
Enhanced U/S Protocol

• Standardized and systematic screening
• Multiple scanning positions
• Multiple probe views
• Various ultrasound modes
Clinical Practice Guideline

- **Annual ultrasound** for all active astronauts
- Use of **specialized ultrasound** protocol
- Suspicion for stone → Low-dose, high resolution **CT**
- Stone by CT → **Flexible Ureteroscopy** preferred
- **Mission assignment** affects treatment method
- **Potential waivers** for very small, stable MRM
US Navy Standards

• **Waivers** given for...
  - calcium oxalate, calcium phosphate, uric acid and struvite;
  - retained stones in the renal parenchyma;
  - recurrent stones > 12 months apart.

• Medical evaluation & urology consult required
US Navy Standards

- Waivers **NOT** given for...
  - recurrent stones within one year
  - cysteine stones
  - hypercalcuria
  - stones retained in the *collecting system*
Where we are…

• **All active astronauts have been screened**
  - 4 were post-flight

• Seven renal panel meetings done

• Prelim results to NASA-AMB Summer 2017
Treatment During a Mission?

Ureteral Stone Size and Time to Passage


Thank you.

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<table>
<thead>
<tr>
<th></th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Dose (mSv)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ultrasound</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average 2.6 mm (1 – 9 mm, SD 1.15 ), n = 51 pts, 114 stones [17]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shadowing alone</td>
<td>65 (PPV 90)</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Twinkling alone</td>
<td>81 (PPV 94)</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Shadowing + Twinkle</td>
<td><strong>88 (PPV 96)</strong></td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Average 3.9 mm (1-20 mm), n = 105 pts, 65 stones, CT as reference [18]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shadowing alone</td>
<td>48 (PPV 81)</td>
<td>99</td>
<td>0</td>
</tr>
<tr>
<td>Shadowing + Twinkle</td>
<td><strong>55 (PPV 67)</strong></td>
<td><strong>99</strong></td>
<td>0</td>
</tr>
<tr>
<td><strong>X-Ray</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KUB</td>
<td>45 - 58</td>
<td>69 - 77</td>
<td>0.7</td>
</tr>
<tr>
<td>IVP</td>
<td>85</td>
<td>90</td>
<td>3</td>
</tr>
<tr>
<td><strong>CT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-dose, non-con.</td>
<td>97</td>
<td>95</td>
<td>3</td>
</tr>
<tr>
<td>Non-contrast</td>
<td>95 – 98</td>
<td>96 - 98</td>
<td><strong>10</strong></td>
</tr>
<tr>
<td><strong>MRI</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>93 - 100</td>
<td>95 - 100</td>
<td>0</td>
</tr>
</tbody>
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