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
General Population

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

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.

David Reyes
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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></td>
<td><strong>Average 2.6 mm (1 – 9 mm, SD 1.15), n = 51 pts, 114 stones [17]</strong></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>88 (PPV 96)</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td><strong>Average 3.9 mm (1-20 mm), n = 105 pts, 65 stones, CT as reference [18]</strong></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>55 (PPV 67)</td>
<td>99</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>
</table>