METABOLIC STONE DISEASE

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BACKGROUND

• Stones affect 12% adult population
• Lifetime recurrence approaches 90%
• 97% of patients have identifiable risk factors
### CALCIUM STONES

![Bar chart showing % risk factors for Ca, Na, Uric, OX, and Cit](Pak 1997, n=3473)

### METABOLIC MANAGEMENT

<table>
<thead>
<tr>
<th>Risk</th>
<th>Data</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low volume</td>
<td>&lt; 2 L</td>
<td>Fluids</td>
</tr>
<tr>
<td>AH 1</td>
<td>UCa, ↓PTH</td>
<td>HCTZ, K citrate, NaCellulosePhos</td>
</tr>
<tr>
<td>AH 2</td>
<td>UCa</td>
<td>Diet, NaCellulosePhos</td>
</tr>
<tr>
<td>Hypocitraturia</td>
<td>U citrate, (pH)</td>
<td>K citrate</td>
</tr>
<tr>
<td>Hyperoxaluria</td>
<td>U Ox, PTH</td>
<td>Diet, pyridoxine, Ca</td>
</tr>
<tr>
<td>Parathyroidism</td>
<td>S Ca ↑PTH</td>
<td>Surgery</td>
</tr>
<tr>
<td>Hyperuricosuria</td>
<td>U UA (S UA), pH</td>
<td>K citrate (allop), diet</td>
</tr>
<tr>
<td>Renal hypercalciuria</td>
<td>UCa, ↑PTH</td>
<td>HCTZ, orthophosphate</td>
</tr>
</tbody>
</table>
URINARY VOLUME

• Increase fluid intake
• Increase urine output
• Decrease mineral supersaturation
• Decrease stone episodes
• Does it work? How well?

URINE OUTPUT

Borghi J Urol 1996; 155: 839

• 199 1st time stone
• 5 yr followup
• Water vs. observe
URINE OUTPUT
Borghi J Urol 1996; 155: 839

- New stones in 12/99 water vs. 27/100 observe
- U Na 158 – 162
- U Ca 244 – 266

FLUIDS VS. URINE
Parks J Urol 2003; 169: 863

- ↑fluid → ↓supersaturation → ↓stones
- “increase fluids, decrease sodium”
- 2877 hypercalciuric patients studied
- 13 sites
- HCTZ vs. no
- Instructed > 2 L/day, < 100 mEq salt
**FLUIDS VS. URINE**

Parks J Urol 2003; 169: 863

- Mean urine output increased 350 ml
- Cutoff 2.8 L

• \( \uparrow \) U vol \( \rightarrow \) \( \uparrow \) U Na

• \( \uparrow \) U vol \( \rightarrow \) \( \uparrow \) U Ca
FLUIDS VS. URINE
Parks J Urol 2003; 169: 863

- ↑ U vol → ↓ U [Ca]
- > 500 cc/day

- ↑ U vol → ↓ SSCaOx
- > 1 L for 50%

FLUIDS VS. URINE
Parks J Urol 2003; 169: 863

- Pts increase Na as they increase volume
- “One would think that nothing could be less complex than the advice to increase urinary volume and decrease urine sodium but in practice this advice is not simple to implement.”
CASE

- 61 yo female recurrent calcium stones
- Vol 867 cc, oxalate 434 umol, sodium 126 mmol
- Increase fluids, decrease oxalate
- Vol 1542 cc, oxalate 384 umol, sodium 258 mmol

TYPES OF FLUID
Curhan NEJM1993; 328: 833

<table>
<thead>
<tr>
<th>Decreased risk</th>
<th>Increased risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tea 14%</td>
<td>Apple juice 35%</td>
</tr>
<tr>
<td>Coffee 10%</td>
<td>Grapefruit juice 37%</td>
</tr>
<tr>
<td>Beer 21-60%</td>
<td></td>
</tr>
<tr>
<td>Wine 39-60%</td>
<td></td>
</tr>
</tbody>
</table>

Water, lemonade
DIET: CA++ VS OXALATE

- Most stones are CaOx
- Molar basis: oxalate > Ca
- Lower dietary calcium ➔ lower U Ca
- Osteoporosis?

DIETARY CALCIUM
Curhan NEJM 1993; 328: 833

<table>
<thead>
<tr>
<th>Diet Ca (mg)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>516</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>664</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>783</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>937</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1326</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>RR</th>
<th>1.0</th>
<th>0.71</th>
<th>0.64</th>
<th>0.61</th>
<th>0.56</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.0</td>
<td>0.71</td>
<td>0.64</td>
<td>0.61</td>
<td>0.56</td>
</tr>
</tbody>
</table>
DIET
Borghi NEJM 2002; 346: 77

- 120 men idiopathic hypercalciuria
- Low Ca vs. normal Ca, low protein/salt
- Increase fluids
- 5 year followup
- Randomized prospective trial
**DIET**
Borghi NEJM 2002; 346: 77

<table>
<thead>
<tr>
<th></th>
<th>Low Ca</th>
<th>Low Ca</th>
<th>N Ca</th>
<th>N Ca</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume</td>
<td>1755</td>
<td>2187</td>
<td>1852</td>
<td>2296</td>
</tr>
<tr>
<td>UNa</td>
<td>227</td>
<td>201</td>
<td>241</td>
<td>123</td>
</tr>
<tr>
<td>UCa</td>
<td>11</td>
<td>6</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>UOx</td>
<td>367</td>
<td>411</td>
<td>411</td>
<td>333</td>
</tr>
<tr>
<td>SS CaO</td>
<td>10</td>
<td>5</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>Stones</td>
<td>23/60</td>
<td></td>
<td>12/60</td>
<td></td>
</tr>
</tbody>
</table>

**OXALATE FOODS**

<table>
<thead>
<tr>
<th>Food</th>
<th>Oxalate mg per serving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spinach</td>
<td>700</td>
</tr>
<tr>
<td>Rhubarb</td>
<td>600</td>
</tr>
<tr>
<td>Fiber One</td>
<td>500</td>
</tr>
<tr>
<td>Wheat bran</td>
<td>400</td>
</tr>
<tr>
<td>Strawberry</td>
<td>300</td>
</tr>
<tr>
<td>Beets</td>
<td>200</td>
</tr>
<tr>
<td>Peanut butter</td>
<td>100</td>
</tr>
<tr>
<td>Broccoli</td>
<td>100</td>
</tr>
<tr>
<td>Tea</td>
<td>100</td>
</tr>
<tr>
<td>Chocolate</td>
<td>0</td>
</tr>
</tbody>
</table>

Smoked meat, vitamin C, Worcestershire sauce, nuts
CASE

• 57 yo woman left flank pain 3 wks
• Similar to prior stones ESWL
• Exam mild L CVAT
• CT KUB 9 mm left UPJ stone
• ESWL

EVALUATION

• Stone: Ca Ox monohydrate
• 24 hr urine: 1.8 L, Ca 3.0 mmol (<7), UA 3, Na 189 (<217), oxalate 555 (<340), citrate 1.1 mmol (1-6)
• ICA 1.26, iPTH 2.3, UA 355 umol (<350)
DIET HISTORY

• Breakfast: tea
• Lunch: turkey sandwich, iced tea
• Dinner: Meat/chicken/fish, spinach/broccoli
• Snacks: chocolate, nuts

CALCIUM VS. OXALATE

Heller J Urol 2003; 169: 470; 2003

• Ca vs Ox UCaOx
• Normals placed on high and low Ca diets (Curhan 5)
• ↑ vol 1814 vs 1591
• ↑pH 6.3 vs. 6.0
• ↑ citrate 849 vs 751
• U Ox no change
**CALCIUM VS. OXALATE**


- Hi Ca moderate Ox does NOT ↓ Uox
- Does not ↓ SSCaOx
- ↑ volume
- ↑ pH
- ↑ K

<table>
<thead>
<tr>
<th>Table 1. Effect of dietary calcium on relative supersaturation ratio</th>
<th>Diet</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High Ca</td>
<td>Low Ca</td>
<td>p Value</td>
<td>(log scale)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative supersaturation ratio calcium oxalate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uncorrected</td>
<td>4.3 ± 0.5</td>
<td>4.5 ± 0.5</td>
<td>0.51</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected for urine vol.</td>
<td>4.0 ± 0.5</td>
<td>4.5 ± 0.5</td>
<td>0.49</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected for urine vol. and other confounding factors</td>
<td>3.0 ± 0.5</td>
<td>4.5 ± 0.5</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
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**DIET AND DRUGS**

Pak J Urol 2003; 169: 465

- Dietary calcium and oxalate restriction
- HCTZ 50 mg, K citrate (40 mEq/2
- Volume 2.2 L → 2.7 L, p<0.001
- U Na 196 mg → 197 mg
- Stones/yr 2.9 → 0.05, p<0.001
**THIAZIDES**
Preminger AUA Update 1995; 14: 6

- Thiazides → hypocalciuria
- ↑bone density
- Effect stabilizes at 2 years
- Decreases citrate
- Effective for AH1 and RH

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**DIET AND DRUGS**
Pak J Urol 2003; 169: 465

- ↓Uca ↓RSR CaOx
- U Ox no change

- ↑BMD
JH 39 yo male right renal calculus

- Stone: Ca oxalate monohydrate
- Serum Ca 9.8, uric acid 6.7, PTH 37
- 24 hr urine: 1.8 L, pH 5, Ca 306, oxalate 74, uric acid 1273, Na 225

DIET HISTORY

- Breakfast: coffee or Dr. Pepper
- Lunch: BBQ, iced tea, “sides”
- Dinner: “I like hamburgers”, cola
## METABOLIC MANAGEMENT

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<td>Hyperoxaluria</td>
<td>U Ox, PTH</td>
<td>Diet, cholestyramine</td>
</tr>
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<td>S Ca PTH</td>
<td>Surgery</td>
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## CASE

- 58 yo male
- Right renal colic x 2 mos
- Urgency, frequency x 3 days
- PMH, PSH negative
- Exam negative
METABOLIC EVALUATION

- Stone Ca Ox monohydrate
- 24 hr urine volume 2 L, Ca 280 mg, UA 640 mg, citrate 312 mg
- Serum ICA 1.31 mmol/L, iPTH 8.6, UA 414

CASE #2

- 38 yo male left renal colic
- 7 prior stones
- PMH COPD psoriasis, ESWL
- Meds topical steroids
- Exam psoriasis
EVALUATION

• 24 hr urine: 2.2 L, Ca 22.5 mmol (< 7), oxalate 455 umol (<440), citrate 2.7 mmol, Na 233 mmol, UA 6 mmol
• Serum Ca 2.48 mmol/L (<2.6), phosphate 0.8 (0.8-1.5), UA 454 umol (<450), alk phos 121
• iPTH 3.2 pmol/L (1-8.2), ICA 1.26 (mmol/L)

EVALUATION

• 1,25 di-OH-vit. D 510 pmol/L (40-120)
• Prednisone (vit D 310, urine Ca 9.9)
• Reduced dietary sodium, oxalate
• K Citrate
CASE

- 57 yo woman left flank pain 3 wks
- Similar to prior stones ESWL
- Prior metabolic evaluation
  hyperoxaluria, cannot maintain diet
- Exam mild L CVAT
- CT KUB 9 mm left UPJ stone
- ESWL

EVALUATION

- Stone: Ca Ox monohydrate
- 24 hr urine: 1.8 L, Ca 3.0 mmol (<7), UA 3, Na 189 (<217), oxalate 455 (<340), citrate 1.1 mmol (1-6)
- ICA 1.26, iPTH 2.3, UA 355 umol (<350)
CB

• 56 yo woman left renal colic x 1 yr
• > 10 stones
• ESWL, ureteroscopy
• PMH: morbid obesity
• PSH: ileogastric bypass
• 1.5 cm left ureteral stone
• ESWL
• COM

EVALUATION

• 24 hr urine: 0.9 L, Ca 1.8 mmol, Ox 1957 umol (<340), citrate 2.5 (1-4), UA 3, Na 85
• ICA 1.19 (1.17-1.29), iPTH 16.3 (<8.2)
WHEN TO EVALUATE?

• All stone-formers? 80% risk at 8 yrs
• 97% metabolic workups risk factors
• Medical compliance → time
• Increase fluids, decrease animal protein
• Limited evaluation
• Full evaluation