Urolithiasis: Why should we care?

• Affects 5% of US men and women
• Men twice as likely to develop calculi
• A metabolic etiology can be found in 97% of people with stone disease
• Recurrent calculi can be prevented in most patients
  • Without treatment, recurrence rate approaches 50% at 10 years
• Estimated cost of ~$2 billion per year
Urolithiasis: types of calculi

- **Calcium Oxalate** (70%)
- Calcium Phosphate (5-10%)
- Uric Acid (10%, Urine pH < 5.5)
- Struvite (15-20%)
- Cystine (1%)
Renal Calculi develop from microscopic crystals in the Loop of Henle, distal tubule, or collecting duct.

Stone formation depends on **urinary volume**, **concentrations of ions** (Calcium, Phosphate, oxalate, sodium, and uric acid), **concentrations of natural inhibitors of calculi** (Citrate, Magnesium, Tamm-Horsfall mucoproteins, bikunin), and **urinary pH**.

**Low Urine Volume, High Ion Levels and Low Citrate Levels** favor Calculus Formation.
Urolithiasis: Risk Factors

- **Low urine volume** (allows stone constituents to supersaturate)
- **Excess dietary meat** (creates acidic urine, depletes citrate, hyperuricosuria)
- **Excess dietary oxalate**
- **Excess dietary sodium** (promotes hypercalciuria)
- **Family history** (genetic predisposition)
- **Insulin resistance** (alters urine pH, ammonia mishandling)
- **Bowel Disease** (low urine volume, acidic urine depletes citrate, hyperoxaluria)
- **Gout** (hyperuricosuria)
- **Obesity** (hypercalciuria)
- **Primary Hyperparathyroidism** (hypercalciuria)
- **Prolonged immobilization** (bone turnover creates hypercalciuria)
- **Renal Tubular Acidosis - Type 1** (alkaline urine promotes CaPhosphosphate supersaturation, loss of citrate)
Urolithiasis: General Recommendations

- Increase Hydration (Urine Volume > 2 L / day)
- Low Animal Fat Diet
- Low protein Diet
- Low Salt Diet
Urolithiasis presentation

- Pain (Renal Colic)
- Nausea / Vomiting
- Fevers/Chills
- LUTS
- Anorexia
Urolithiasis: Work up

• History & Physical

• Labs: CBC, BMP, UA, UCx

• Imaging
Urolithiasis: diagnosis

- KUB
- IVP
- US
- NCCT
You Have a stone: What next?
Urolithiasis: urologic consultation

- Unyielding, uncontrolled pain
- Nausea/vomiting
- Stone > 5mm
- Fever, UTI
- Renal dysfunction, obstructive uropathy
Urolithiasis
indications for admission and intervention

• Complete or High Grade Obstruction
• Any Degree of Bilateral Urinary Obstruction
• **Solitary Kidney** with Any Degree of Urinary Obstruction
• Any Degree of Urinary Obstruction with **Fever or Leukocytosis**
• Any Degree of Urinary Obstruction with **Azotemia / Renal dysfunction**
• Obstruction in **Diabetic** or **Immunocompromised** Patients
• **Inability to Tolerate PO** Intake due to N/V
• Severe Pain NOT controlled with oral Analgesics
• Stone that is Unlikely to Pass due to **SIZE and/or LOCATION**
Urolithiasis
Likelihood of spontaneous passage based on size & location

- 1 mm stone = 90% (~ 8 days)
- 5 mm stone = 56% (~22 days)
- 9 mm stone = .3%

- 90% of stone 5 mm or less will pass within 40 days
- smaller and more distal stones more likely to pass
Urolithiasis: Management options

• Trial of Passage
• Medical expulsive therapy
• Urinary diversion
  • ureteral stent
  • percutaneous nephrostomy tube
• Extracorporeal Shock Wave Lithotripsy (ESWL)
• Endoscopic management
  • Ureteroscopy (URS)
  • Percutaneous Nephrolithotomy (PCNL)
• Open stone surgery
Urolithiasis: Management options

**medical expulsive therapy**

- Alpha-1 receptors are located in the human ureter, especially the distal ureter.

- **Alpha-blockers** (i.e., Flomax or Tamsulosin)
  - increase expulsion rates of distal ureteral stones
  - decrease time to expulsion
  - decrease need for analgesia during stone passage. Alpha-blockers
  - promote stone passage in patients receiving shock wave lithotripsy
  - may be able to relieve ureteral stent-related symptoms

- In the appropriate clinical scenario, the use of α-blockers is recommended in the conservative management of distal ureteral stones.
Urolithiasis: Management options

medical expulsive therapy

Table 1
Rates of Stone Expulsion for Distal Ureteral Stones in Patients Treated With Alpha-1-Blocker Versus Patients Treated With Standard Medical Expulsion Therapy Without Alpha-1-Blocker

<table>
<thead>
<tr>
<th>Study</th>
<th>With Alpha-1-Blocker (%)</th>
<th>Without Alpha-1-Blocker (%)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cervenakov et al.</td>
<td>80.4</td>
<td>62.8</td>
<td>N/A</td>
</tr>
<tr>
<td>Dellabella M et al.</td>
<td>100</td>
<td>70</td>
<td>.001</td>
</tr>
<tr>
<td>Redim S et al.</td>
<td>86.6</td>
<td>73.3</td>
<td>.196</td>
</tr>
<tr>
<td>De Sio M et al.</td>
<td>90 (tamsulosin)</td>
<td>58.7</td>
<td>.01</td>
</tr>
<tr>
<td>Yilmaz E et al.</td>
<td>79.31 (terazosin)</td>
<td>53.57</td>
<td>.03</td>
</tr>
</tbody>
</table>

Table 2
Time to Stone Expulsion for Distal Ureteral Stones in Patients Treated With Alpha-1-Blocker Versus Patients Treated With Standard Medical Expulsion Therapy Without Alpha-1-Blocker

<table>
<thead>
<tr>
<th>Study</th>
<th>With Alpha-1 Blocker</th>
<th>Without Alpha-1 Blocker</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dellabella M et al.</td>
<td>85.7 h</td>
<td>111.1 h</td>
<td>.02</td>
</tr>
<tr>
<td>De Sio M et al.</td>
<td>4.4 d</td>
<td>7.5 d</td>
<td>.005</td>
</tr>
<tr>
<td>Yilmaz E et al.</td>
<td>6.31 d (tamsulosin)</td>
<td>10.54 d</td>
<td>.04</td>
</tr>
<tr>
<td></td>
<td>5.75 d (terazosin)</td>
<td>10.54 d</td>
<td>.03</td>
</tr>
<tr>
<td></td>
<td>5.93 d (doxazosin)</td>
<td>10.54 d</td>
<td>.03</td>
</tr>
<tr>
<td>Porpiglia F et al.</td>
<td>7.9 d</td>
<td>12 d</td>
<td>.02</td>
</tr>
<tr>
<td>Dellabella M et al.</td>
<td>72 h</td>
<td>120 h</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>
Urolithiasis: urinary diversion

Ureteral stent

- The stent starts here. Urine drains into it to leave the kidney.
- The stent allows urine to bypass a blockage.
- The stent ends here. Urine drains out of it, into the bladder.
Urolithiasis: urinary diversion

Percutaneous Nephrostomy tube
Urolithiasis: Management options

ESWL (Extracorporeal Shockwave Lithotripsy)

Extracorporeal shock wave lithotripsy (ESWL) machine

Shock waves break up stone in ureter
Urolithiasis: Management options

Management depends on stone location and size

Figure 1 - Algorithm for a rational approach to contemporary management of renal calculi.

Comparing Ureteroscopy, Shockwave Lithotripsy, & Percutaneous Nephrolithotripsy

- **Ureteroscopy**
  - Description: Small flexible camera used to insert stone and remove it. Laser fiber used to fragment stone.
  - Benefits: Highest access rate for small to medium stones.
  - Typical Operative Time: 1 hour
  - Usual Hospital Stay: Usually none
  - Average Days Before Back to Work: 8.5
  - Average Days Before 100% Recovered: 63%
  - % of Patients Who Would Have Stones Again: 90%

- **Shockwave Lithotripsy**
  - Description: Uses focused sound waves from outside the body to fragment a stone. It is used to target stones that are too large for the patient to pass on their own.
  - Benefits: Least discomfort.
  - Typical Operative Time: 1/2 hour
  - Usual Hospital Stay: None
  - Average Days Before Back to Work: 3.3
  - Average Days Before 100% Recovered: 90%
  - % of Patients Who Would Have Stones Again: 63%

- **Percutaneous Nephrolithotripsy**
  - Description: Small incision made into abdomen through the skin of the back. Allows large instruments to be used which can break up and suction out stone fragments.
  - Benefits: Best option for large stones.
  - Typical Operative Time: 1-2 hours
  - Usual Hospital Stay: 1-2 days
  - Average Days Before Back to Work: + (see estimate 1 week)
  - Average Days Before 100% Recovered: + (see estimate 2 weeks)
  - % of Patients Who Would Have Stones Again: + (no data available)

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Management depends on stone **location** and **size**
Urolithiasis: Management options

Ureteroscopic management

- Ureteroscopy
  - Stone basket manipulation
  - Laser lithotripsy
  - +/- ureteral stent
Urolithiasis: Management options

PCNL
Urolithiasis: Management options

Management depends on stone location and size.

Diagram:
- **Nephrolithiasis suspected**
  - **Renal Calculi**
    - **Simple Renal Calculi** (stone burden <2cm)
      - Shock Wave Lithotripsy (works in >85% patients)
    - **Complex Renal Calculi** (stone burden >2cm)
      - Percutaneous Nephrolithotomy
      - Does not work?
  - **Ureteral Calculi**
    - **Proximal Ureteral Calculi**
      - ≥ 2cm
      - < 1cm
      - < 1cm
    - **Distal Ureteral Calculi**
      - > 1cm
      - Flexible Ureteroscopy
Urolithiasis: Management options

Open stone surgery
Urolithiasis: prevention

• After initial stone episode has resolved, patient should be counseled about preventing recurrences.

• History & Physical
  • Age of onset, frequency and number of previous stones, previous interventions
  • Evaluation of risk factors and dietary habits

• Prior stone composition (stone analysis)

• Laboratory studies
  • BMP, calcium, phosphate, uric acid, intact parathyroid hormone (as indicated)

  • 24 hour urine collection

• Follow-up Imaging (KUB, NCCT)
Urolithiasis prevention

Stone episode (resolved)

Previous episode?

No

Conservative management:
- Increase urine output to 2.1 qt (2 L) per day.
- Consider lower sodium intake.
- Consider lower meat intake (all types).

Yes

Obtain history: Number of previous episodes, onset of previous episodes, bowel disease, gout, diabetes, medications, family history

Serum studies
24-hour urine studies

Uncomplicated calcium stone disease
(i.e., normocalcemia, no bowel disease, no urinary tract infection)

Normocalciuria
- Prescribe potassium citrate (Urocit-K).

Hypercalciuria
- Treat with thiazide diuretics.

Other stone disease

Cystinuria
- Prescribe tiopronin (Thiola) and increase fluid intake.

Uric acid calculi
- Prescribe potassium citrate.

Hypercalciemia
- Hyperparathyroid investigation

Hyperuricemia
- Prescribe allopurinol.

Struvite calculi
- Add acetohydroxyacid (Lithostat) for severe infection stones.

Treat relapses with allopurinol (Zyloprim).

Treat based on findings.
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