Urologic Stone Disease Diagnosis and Treatment

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Urologic Stone Disease

Ureteral calculus

Obstruction of flow

I will not cut, even for the stone, but leave such procedures to the practitioners of the craft

Hippocrates

Urologic Stone Disease

• Epidemiology
• Classification
• Presentation
• Imaging
• Treatment
• Prevention

Urologic Stone Disease: Epidemiology

• Prevalence = 2-3% will have urinary tract stone disease
• Nephrolithiasis incidence as high as 12% in industrialized countries
• Recurrence rates for first time stone formers:
  – 10% first year, 35% at 5 yrs, 50% at 10 yrs
• Men > women
  – Risk of caucasian male getting a stone by age 70 is approximately 1 in 8.
Urologic Stone Disease: Epidemiology

• Peak age of incidence = 20’s to 40’s
• Male / Female ratio = 3/1
  – Children: ratio is equal
• Geography important..."Stone Belt"
  – Increased in mountains, desert, and tropics
  – Southeast (calcium oxylate stones)
  – East coast (uric acid stones)
• Season important
  – Higher in summer months

• Water intake
  – How much you drink
    • “the solution to pollution is dilution”
  – What kind of water you drink
    • Presence of excess minerals (sodium carbonate in hard water) or lack of them (zinc)
• Diet (multifactorial)
• Occupation
  – Sedentary jobs higher risk

Urologic Stone Disease: Stone composition

• Calcium Oxylate
  – Most common kind of stone
  – Most of these patients have hypercalciuria
  – Radio-opaque
• Uric Acid
  – Low urine pH (<5.5)
  – ?gout...increased uric acid load, pH more important
  – Inflammatory bowel disease (dehydration, bicarb loss)
  – Radiolucent

• Infection stones (Struvite)
  – Caused by UTI with urease-producing bacteria (ie Proteus, Klebsiella, Pseudomonas)
  – May grow quite large (Staghorn calculus)
  – Tend to harbor bacteria
  – Radio-opaque
• Cystine Stones
  – Autosomal recessive disorder
  – Cystinuria (cystine poorly soluble)
  – Dense stones, radio-opaque

• Medication stones
  – Triamterine (Dyazide, Maxide)
  – Laxative abuse (ammonium acid urate stones)
  – HIV + patients on triple drug therapy
    • Indinavir crystals
    • Radiolucent (X-ray and CT)

• Renal Colic
  – Abrupt onset
  – Affects patient whether sedentary or active
  – Radiating: flank to groin
  – Associated with bladder irritation if distal
  – Nausea, emesis common
  – Ileus, diarrhea can be present
### Urologic Stone Disease: Presentation

- **Urinalysis**
  - Microscopic or gross hematuria (90%)
  - ? Infection
    - Elevates urgency of management
    - May indicate etiology of stone
  - pH important
  - crystals

### Urologic Stone Disease: Imaging

- **Plain Abdominal film**
  - Stone visualization variable (bowels, bones, etc)
  - Excellent way to follow radio-opaque stones
  - Can be fooled by calcifications outside of the urinary system

- **Intravenous Urogram (IVP)**
  - Valuable to outline anatomy, stone location, and obstruction
  - Requires good bowel prep for optimal films
  - If significant obstruction, may not identify point of obstruction

- **Renal Ultrasound**
  - Stones will "shadow", but small ones may be missed
  - Renal calculi well seen, ureteral calculi difficult to see
  - Can document Hydronephrosis

- **Computed Tomography**
  - Becoming the standard (non-contrast helical CT)
  - Cost similar to IVP
  - Rapid assessment
  - Location/size of stone
  - Secondary signs of obstruction (stranding, hydronephrosis)
Urologic Stone Disease

- Epidemiology
- Classification
- Presentation
- Imaging
- Treatment
- Prevention

Treatment Options for Urologic Stones

- Observation
- Chemo-dissolution
- Extracorporeal Lithotripsy (ESWL)
- Percutaneous stone surgery
- Ureteroscopy with laser lithotripsy
- Open stone surgery

Urologic Stone Disease: Treatment

- What do the treatment of stone disease and the sale of real-estate have in common?

- LOCATION, LOCATION, LOCATION

Observation

- Successful passage dependent on size
  - <4mm – approx. 90% pass
  - 4 – 8mm – approx. 40% pass
  - >8mm – less than 10% pass
- Can wait up to 6 weeks
- Monitor for infection, stone movement

Chemo-dissolution

- Sounds great, but……
- Can work for Uric acid calculi
  - Raise urine pH >6
  - Sodium Bicarbonate, Urocit-K, Potassium Citrate
- For calcium containing stones
  - No safe, effective agents

ESWL

- Utilizes focused shock waves generated by various means to fragment the stone
- Ideal for kidney stones
- Lower pole stones, large stones, ureteral stones, poorly visualized stones are problematic
- Must then pass the fragments
Percutaneous Stone surgery

- Percutaneous access to the kidney through the flank
- Ideal for large stone burden
- Utilize ultrasound/aspiration, laser, pneumatic impacting devices to fragment and remove stone
- Can render patients with large stone burdens “stone free” in one or two procedures

Ureteroscopy

- Access through existing channels (bladder and ureter)
- Utilizes small diameter scopes to visualize, fragment, and remove stones
- Ideal for ureteral calculi, smaller renal calculi

Ureteroscopy “Toys”

- Graspers
- Graspers and baskets
- Lasers

Ureteroscopy: Semi-rigid ureteroscope

Factors to Consider

- Size of the stone
- Location of the stone
  - Kidney (upper, middle, lower)
  - Ureter (proximal vs. distal)
- Composition of the stone
  - “hard vs. soft”
- Previous history
  - Previously passed stones
- Presence of infection
  - emergency
Stone Treatment Factors

- **Size**
  - **<4mm**
    - Kidney – Observe vs. ESWL
    - Ureter – Observe, treat if colic or not moving
  - **4 – 8mm**
    - Kidney – ESWL
    - Ureter – Treat, ureteroscopy vs ESWL
  - **8 – 15mm**
    - Kidney – ESWL
  - **Over 15mm or complex stone**
    - Kidney – Percutaneous removal

Stone Treatment Factors

- **Location**
  - **Kidney**
    - ESWL for stones less than 1.5 – 2cm
    - Percutaneous approach for large or lower pole stones
  - **Ureter**
    - Ureteroscopy for any location
      - Flexible ureteroscope for upper ureter
      - Semi-rigid ureteroscope for lower/mid ureter
    - ESWL for upper ureteral stones that are well seen

Right Mid-ureteral calculus: Stent in place

Holmium laser fiber on a ureteral calculus

Calculus has been partially fragmented

Patients with Residual Calculi: Size of Original Stone

<table>
<thead>
<tr>
<th>Size</th>
<th>% of Original Size</th>
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<tbody>
<tr>
<td>&lt;1mm</td>
<td>0</td>
</tr>
<tr>
<td>1-5mm</td>
<td>10</td>
</tr>
<tr>
<td>6-10mm</td>
<td>20</td>
</tr>
<tr>
<td>11-20mm</td>
<td>30</td>
</tr>
<tr>
<td>&gt;20mm</td>
<td>50</td>
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ESWL Treatment of Upper Ureteral Calculi

<table>
<thead>
<tr>
<th>Litho</th>
<th>Stone Free (%) 3 mo</th>
<th>Proximal</th>
<th>Mid</th>
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<tbody>
<tr>
<td>HM-3</td>
<td>91</td>
<td>91.2</td>
<td></td>
</tr>
<tr>
<td>MFL-5000</td>
<td>81.3</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>HM-4 &amp; MPL-9000</td>
<td>68.5</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>Piezolith &amp; LTO2</td>
<td>70.2</td>
<td>73.4</td>
<td></td>
</tr>
<tr>
<td>Lithostar</td>
<td>82.4</td>
<td>81.1</td>
<td></td>
</tr>
<tr>
<td>Modulith</td>
<td>81.0</td>
<td>80.0</td>
<td></td>
</tr>
</tbody>
</table>

Ureteroscopy

Distal Ureteral Calculi: Success of Treatment

<table>
<thead>
<tr>
<th>Period</th>
<th>Success Rate</th>
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<tbody>
<tr>
<td>1990 - 1995</td>
<td>91.2%</td>
</tr>
<tr>
<td>1996 - 2001</td>
<td>96.4%</td>
</tr>
</tbody>
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Urologic Stone Disease: Follow-up

- Stone Analysis
- KUB and Renal U/S
  - Rule out residual fragments, silent hydronephrosis, new stones
- Metabolic evaluation
  - Recurrent stone formers
  - Young patients with positive family history of stones
  - Bilateral stones

Metabolic Stone Work up

- Complete Serum metabolic panel
  - Calcium, Uric acid, Creat., Bicarbonate
- U/A
- 24 hour urine collection
  - Sodium, calcium, Phosphorus, Oxylate, Uric acid, Citrate, magnesium
  - Volume, urine pH

Metabolic Stone Work up: Common Problems

- Low Urine volume (<2 liters/day)
  - Increased super saturation of Calcium oxylate and or uric acid
  - Treatment: drink more water!
- High urine sodium (another Diet Coke please)
  - Increases urine calcium
  - Treatment: Decrease dietary sodium

Metabolic Stone Work up: Common Problems

- Increased urinary calcium
  - Hyperparathyroidism
    - Treat primary disease
  - Renal leak (high fasting urine calcium)
    - Thiazide diuretic
  - Hyper absorption (normal fasting urine calcium)
    - Dietary restriction of calcium
Metabolic Stone Work up: Common Problems

- **Low Urine Citrate**
  - Citrate is a stone “inhibitor”
  - Lowered with thiazide diuretics
  - Treatment: Potassium citrate or Urocit-K, alternative is “lemonade therapy”
    - Lemons are good source of citrate with the least calcium and sodium

- **High urinary oxylate**
  - Can result from calcium restriction
  - Treatment: Adequate calcium, dietary restriction

Metabolic Stone Work up: Common Problems

- **Dieting**
  - “Atkins” diet or similar…low carb, high protein
  - Urine gets acidified (ash)
  - Uric acid load up
  - Obesity is risk factor for stones independently
  - Stone risk increased
  - Counterbalanced by hydration and possibly alkalization (potassium citrate)

Urologic Stone Disease: Summary

- Common problem with classic presentation (colic)
- Diagnosis commonly made with spiral CT
- Treatment based on size and location of the stone
  - Ureteroscopy, ESWL, percutaneous
- Metabolic evaluation and treatment recommended for recurrent stone formers or those at risk

Thank You