From Rocks to Dust: Nephrolithiasis & the Kidney Stone Diet

Presented by:
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Who is our Audience Today?

- Dietitians
- Nurses
- Pharmacists
- Physicians
- Social Workers
Do you care for individuals with nephrolithiasis...

* Daily
* Weekly
* Monthly
* <Monthly
* Never
Pre-test 1

• All of the following are effective treatments for kidney stone except:
  • Low animal protein diet
  • Low sodium diet
  • Citrate supplementation
  • Dietary calcium restriction
  • Increased fluid intake
What is the most common type of kidney stone?

- Calcium oxalate
- Uric acid
- Drug
- Struvite
- Cystine
NEPHROLITHIASIS – A PAINFUL PROBLEM!

- Affects approx 10% of adults
  - Slight male predominance
- Incidence varies geographically
- Approx 50% have one or more recurrence at 10 years
  - Detailed evaluation generally performed for recurrent stone formers
- Can cause significant morbidity
- Rare cause of end-stage kidney failure
Pathophysiology

- Supersaturation
- Stasis
- Structural abnormality
Medullary Sponge Kidney
Types of Stones

- **Calcium**
  - Calcium oxalate
  - Calcium phosphate

- **Uric acid**

- **Struvite ‘staghorn’**
  - Magnesium ammonium phosphate

- **Drug-related**
  - Creation of metabolic environment favouring stone formation
  - Crystallization of drug itself when supersaturated in urine

- **Rare Stone Disorders:**
  - APRT Deficiency, Dent Disease, Cystinuria, Primary hyperoxaluria
How Can I Tell What Type of Stone My Patient Has?

- **History**
  - Age, comorbidities, medications, family history, occupation / environment, prior kidney or GI surgery

- **Physical**
  - Urinalysis
    - presence of crystals

- **Lab testing**
  - Serum: creatinine, bicarbonate, calcium, PTH, glucose/HgA1c, uric acid
  - Urine (24 hr): calcium, uric acid, oxalate, sodium, citrate
  - Urine pH: uric acid crystals form in acidic urine, calcium phosphate crystals form in alkaline urine, urine is alkaline with struvite stones

- **Imaging:**
  - Radiolucent (uric acid stones) vs opaque (most other stones)
  - ? Nephrocalcinosis

- **Stone Analysis**
Selected Medications

- Change urine pH or composition:
  - Vitamin C
  - Vitamin D
  - Calcium (ie. CaCO3)
  - Diuretics: carbonic anhydrase inhibitors, loop diuretics

- Drug precipitates:
  - Antimicrobials: acyclovir, amoxicillin, ampicillin, ceftriaxone, ciprofloxacin, sulfamethoxazole
    - Protease inhibitors: indinavir
  - Guaifenesin
  - Triamterene
  - Methotrexate
Calcium Oxalate

- Most common (80-85%)
- Presumed diagnosis unless atypical features
- Higher incidence:
  - Post (partial) bowel resection
  - High dose Vitamin C
  - Family history
- Hypercalciuria not necessary
- Hyperoxaluria not necessary
Uric Acid Stones

- Reasonably common
- Risk factors:
  - Gout
  - Chronic diarrhea
  - Obesity
  - Metabolic syndrome / DM
  - Malignancy
- Not seen on plain X-ray
- Hyperuricosuria common
Struvite Stones

- Magnesium ammonium phosphate + calcium carbonate
- Formed in infected upper urinary tract:
  - Females, neurogenic bladder, urinary diversion
  - Can grow quickly so often present late
    - UTI symptoms, flank pain, gross hematuria
  - pH > 7
- Antibiotics and surgical removal required
Cystine Stones

- Cystinuria 1/7000 live births
  - Reduced renal absorption cystine (plus ornithine, lysine, arginine)
- +/- Family history
- Often presents in childhood
- Can form staghorn calculi
- Less radiopaque than calcium stones
What proven treatments are there?

- Increasing fluid intake
- Thiazide diuretic (reduces urine calcium)
- Allopurinol (reduces urine uric acid)
- Citrate (raises urine citrate / raises urine pH)
Other Treatments

- Diet
- Oral calcium (oxalate binding)
- Disease-specific
  - i.e. captopril or penicillamine for cystinuria
- Analgesia
- Alpha blockers (relax smooth muscle tone of ureters to help stone pass / relieve colic)
- Lithotripsy
- Surgical
  - Endoscopic
  - Percutaneous
  - Open
- MEDICAL THERAPY DOES NOT DISSOLVE STONES
Case 1 – Patient AS

- 34 F 4 year history of recurrent nephrolithiasis, onset with renal colic at age 26 when pregnant
  - Every 6 months, then monthly severe colic
  - Stone obstruction twice (9mm, 1.2cm); bilateral ureteric obstruction with urosepsis
  - Ureteric stents placed on multiple occasions
- No family history
- CT-KUB consistent with medullary sponge kidneys; multiple bilateral calculi up to 3 mm in size
Normal serum biochemistry

Stone analysis: calcium oxalate

Urinalysis: pH 6.5, RBC 40-100/hpf

24 hr urine:
- Volume 3.7 L
- Calcium 5.2 (2.2-6.5 mmol/d)
- Oxalate 344 (40-340 umol/d)
- Citrate 4.44 (0.7-4.9 mmol/d)
- Sodium 207 (40-220 mmol/d)
- Uric acid 3.4 (1-3.8 mmol/d)
AS – follow up 3 years later…

- Therapy:
  - HCTZ 12.5 mg po BID
  - Potassium citrate 50 mEq po TID
  - Prazosin 1 mg po OD
  - Cipro 500 mg po OD
  - Endoscopic stone extraction & laser lithotripsy x2

- Urine pH 8.5
- Urine volume still high, biochemistry still normal
- Right hydronephrosis with multiple impacted ureteric stones – currently awaiting surgery
Case 2 - Patient WM

- 32 F of Chinese descent, presented with creatinine 106 on routine lab testing
  - U/S: nephrocalcinosis, bilateral hydronephrosis, cortical thinning
  - CT: staghorn calculi bilaterally, multiple intrarenal stones
- Extensive surgery / subsequent surgeries
- Pregnancy with nephrolithiasis complicating
- Urine amino acid electrophoresis: urine cystine excretion 4x normal
- Increased fluids, diet control, and K citrate
Onto nutrition therapy...
Agenda

- Types of stones
- Nutritional risk factors
- Nutritional assessment
- Evidence
- Challenges
- Post test
The Stones that Roll In…

- Most common: calcium oxalate & uric acid
- Struvite stone
- Clients can have various ones over time, i.e. calcium oxalate, uric acid
Nutritional Risk Factors

- Obesity
- Diabetes
- Gout
- Gastrointestinal complications
Nutritional Assessment

- Assess the 24 hour urinalysis
  - Urine volume, calcium, oxalate, sodium, citrate, uric acid, pH (if completed)
- Assess 3 day diet record
  - Fluid intake, salt, sugar, caffeine, protein, calcium, oxalate
- Assess vitamins/minerals/herbal remedies
  - Vitamin C dose?
  - Herbal remedies
# Case Study: 55 year old female

<table>
<thead>
<tr>
<th>MEAL</th>
<th>FOOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td>-All-Bran cereal with 1/2C milk</td>
</tr>
<tr>
<td></td>
<td>-Coffee</td>
</tr>
<tr>
<td></td>
<td>-1 banana</td>
</tr>
<tr>
<td>Lunch</td>
<td>-1C canned soup</td>
</tr>
<tr>
<td></td>
<td>-4 crackers with cheese</td>
</tr>
<tr>
<td>Dinner</td>
<td>-Frozen dinner</td>
</tr>
<tr>
<td></td>
<td>-1C juice</td>
</tr>
<tr>
<td>Snacks:</td>
<td>-salted nuts, candy, chocolate, cookies</td>
</tr>
<tr>
<td>Fluid intakes:</td>
<td>Water: 750ml; Coffee: 2C; Juice: 1-2C</td>
</tr>
</tbody>
</table>
She presents with the following 24 hour urinalysis:

<table>
<thead>
<tr>
<th>LAB</th>
<th>VALUE</th>
<th>REFERENCE RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine volume</td>
<td>1500 ml</td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>3.4</td>
<td>1.0-7.0</td>
</tr>
<tr>
<td>Oxalate</td>
<td>1297</td>
<td>40-340</td>
</tr>
<tr>
<td>Citrate</td>
<td>0.8</td>
<td>1.0-6.0</td>
</tr>
<tr>
<td>Uric acid</td>
<td>2.4</td>
<td>1.5-4.5</td>
</tr>
<tr>
<td>Sodium</td>
<td>254</td>
<td>40-220</td>
</tr>
</tbody>
</table>
Analyzing the 24 hour urinalysis

- Urine volume = low
- Oxalate = elevated
- Citrate = low
- Sodium = elevated
# Nutritional Concerns

<table>
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<tr>
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</tr>
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| Breakfast| - **All-Bran cereal** with 1/2C milk  
           - Coffee  
           - 1 banana |
| Lunch    | - **1C canned soup**  
           - 4 crackers with **cheese** |
| Dinner   | - **Frozen dinner**  
           - 1C juice |
| Snacks:  | - **salted nuts**, candy, chocolate, cookies, fruit |
| Fluid intakes: | **Water:** 750ml; **Coffee:** 2C;  
                                    **Juice:** 1-2C |
Nutritional Concerns cont.

- All bran cereal, nuts, chocolate $\rightarrow$ Oxalate
- Canned soup, cheese, frozen dinner, salted nuts $\rightarrow$ Sodium
- Juice, candy $\rightarrow$ Sugar
- Low fluid intake
- Inadequate calcium intake
Dietary Recommendations

- Increase fluid intakes: 2.5-3L (10-12C)
  - Includes: water, milk, juice, tea, & soup
- Limit high oxalate content food
- Monitor sodium
- Reduce refined sugars
- Citrate therapy
- Meet calcium requirements for age/gender
# Case Study: 41 year old male

<table>
<thead>
<tr>
<th>MEAL</th>
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</tr>
</thead>
</table>
| Breakfast | -2 slices bacon, 1 egg, 2 slices toast  
-Black tea |
| Lunch    | -2 C mixed green salad with almonds and 1 C tuna |
| Dinner   | -5 oz. steak, ½ mashed potatoes, ½ C asparagus   |
| Snacks:  | -nuts, fruit, black tea                          |
| Fluid intakes: | Water: 1500 ml; Black tea: 2C              |
He presents with the following 24 hour urinalysis:

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<th>LAB</th>
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<th>REFERENCE RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine volume</td>
<td>1800 ml</td>
<td></td>
</tr>
<tr>
<td>Oxalate</td>
<td>303</td>
<td>40-340</td>
</tr>
<tr>
<td>Citrate</td>
<td>2.5</td>
<td>1.0-6.0</td>
</tr>
<tr>
<td>Uric acid</td>
<td>6.0</td>
<td>1.5-4.5</td>
</tr>
<tr>
<td>Sodium</td>
<td>140</td>
<td>40-220</td>
</tr>
</tbody>
</table>
Analyzing the 24 hour urinalysis

- Urine volume = Low <2L
- Uric Acid = Elevated
- Sodium
# Nutritional Concerns

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<td>Fluid intakes:</td>
<td>Water: 1500 ml; Black tea: 2C</td>
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</table>
Nutritional Concerns cont.

- Bacon, egg, tuna, steak → Uric acid
- Sodium intakes
- Calcium intakes
Dietary Recommendations

- Limit intake of meat & alternatives to 2-3 servings/day (1 serving = 2.5 oz)
- Increase fluid 2.5 L
- Limit sodium intakes
- Meet calcium requirements for age/gender
Evidence : Fluid Intake

- Low strength evidence that, compared to no treatment, **increased fluid intake** to maintain daily u/o of >2L/day significantly reduces risk of stones.

- High fluid intake (>2.5L/d) decreases risk for kidney stones in adults with no previous history.
Evidence: Calcium

- Limited evidence shows that restricting calcium will increase stone formation.
- Elevated calcium in urine is responsible for calcium-containing stones.
- Some evidence shows high intake of dietary calcium appears to decrease risk for symptomatic kidney stones.
Evidence: Oxalate

- Limited evidence shows that lowering dietary oxalate will reduce risk of calcium oxalate stones.
- Oxalate bioavailability varies in food – although a food may be high in oxalate, its bioavailability may be low, i.e. swiss chard.
Evidence: Protein

- Protein from animal sources increases the excretion of calcium, oxalate, and uric acid in urine.
- Limited evidence supports that high urine uric acid excretion increases the risk of calcium oxalate stones.
Citrate Therapy

- May work to increase urinary citrate + pH, which reduces CaOx crystal formation
- Evidence does show increase of urinary citrate with citrate therapy alone
- More significant changes seen with K-Citrate
- K-Citrate + citrate therapy is more effective than citrate therapy alone
Challenges

- Individuals with:
  - Heart disease
  - Diabetes
Stone Cold Recommendations

- Suggest 2.5-3L fluids/day
- Limit high oxalate content foods
- Meet recommendations for calcium
- Monitor sodium intakes
- Enjoy 2-3 servings from meats & alternatives group
Post Test - 1

- What is the most common type of kidney stone?
  - Calcium oxalate
  - Uric acid
  - Drug
  - Struvite
  - Cystine
All of the following are effective treatments for kidney stone except:

- Low protein diet
- Low sodium diet
- Citrate supplementation
- Dietary calcium restriction
- Increased fluid intake
Questions??
References


