Urinary Stones: Simplified Metabolic Evaluation

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Urinary Calculus Disease

Incidence: 7-21/10,000
3 men: 1 woman
Peak age of onset: 20-30 years
Morbidity > Mortality

Urinary Calculus Disease

Calcium oxalate
Monohydrate / Dihydrate
Calcium phosphate
Brushite / Apatite
Struvite
Infection stones
Uric acid
pH < 5.5
Cystine
SLC 3a1

General dietary recommendations
Decrease sodium intake
Eliminate salt shaker at table
Assess sodium when shopping
Eating out increases sodium intake
Decrease animal protein intake
Oral fluid intake adequate to void 1.5 L/day
Urinary Calculus Disease

Hypercalciuria
Hyperuricosuria
Hyperoxaluria
Hypocitraturia

Calcium Nephrolithiasis

Hypercalciuria
- Absorptive
  - Type 1
  - Type 2
  - Type 3
- Resorptive
- Renal

Hyperuricosuria
- Endogenous
  - Dietary excess
- Renal

Hypocitraturia
- Metabolic acidosis

Hyperoxaluria
- Primary
  - Enteric

Urinary Calculus Disease

Hypercalciuria - Absorptive
- Intestinal hyperabsorption - jejunum and ileum
- Increased filtered load of calcium
- Parathyroid suppressed
- Decreased tubular absorption
- Attempt to maintain normal serum calcium
Urinary Calculus Disease

Absorptive Hypercalciuria - Type 1
Increased urinary calcium

Low dietary calcium intake
AND
High dietary calcium intake

Urinary Calculus Disease

Absorptive Hypercalciuria - Type 1
Treatment: Cellulose phosphate
Non-absorbable exchange resin
Oral
Binds intraluminal calcium
Limits intestinal absorption
Urinary calcium back to normal
Does not effect calcium transport

Urinary Calculus Disease

Absorptive Hypercalciuria - Type 1
Treatment: Cellulose phosphate
10-15 grams (oral) with meals
Relative contra-indication
Growing children
Post-menopausal women
No change in bone density

Urinary Calculus Disease

Absorptive Hypercalciuria - Type 1
Treatment: Cellulose phosphate - complications
Inappropriate therapy
Negative calcium balance
Parathyroid stimulation
Appropriate therapy
Magnesium binding
Secondary hyperoxaluria
Absorptive Hypercalciuria - Type 1
Thiazide therapy
  Reduction in calcium excretion
  Calcium may be deposited in bone
    When sites saturated - loss of effect
  Limited long-term effect
  No change in intestinal absorption

Absorptive Hypercalciuria - Type 1
Treatment
  Cellulose phosphate
  Thiazide (short - term)

Absorptive Hypercalciuria - Type 2
Increased urinary calcium
  ONLY
  During high dietary calcium intake

Absorptive Hypercalciuria - Type 2
Same as Type 1
  Normocalciuria (<4mg/kg/24-hours)
  Except
    Requires a calcium restricted diet
Absorptive Hypercalciuria - Type 3

**Phosphate**
- Renal leak
- Decreased phosphate
- Increased Vitamin D synthesis
- Increased intestinal absorption
  - Phosphate and calcium
  - Increased renal excretion of calcium

**Treatment**
- Bio-available phosphate
  - Orthophosphate
  - Neutraphos 250mg
  - 3 - 4 times/day

Hypercalciuria - Resorptive

- Primary hyperparathyroidism
  - Increased intestinal calcium absorption
  - Increased bone resorption
  - Increased serum calcium
  - Increased filtered load of calcium
- Hypercalciuria
- Hypercalcemia
- Hypophosphatemia
- Elevated serum PTH
Urinary Calculus Disease

Hypercalciuria - Renal
- Renal tubular absorption of calcium - awry
  - Decreased serum calcium
  - Increased parathyroid hormone
    - Mobilization of bone calcium
  - Increased calcium absorption
  - Increased serum calcium
    - Renal tubular leak

Hypercalciuria - Renal
- Normocalcemia
- Elevated fasting urinary calcium
- Elevated PTH

Hypercalciuria
Hyperuricosuria
Hyperoxaluria
Hypocitraturia
Urinary Calculus Disease

Hyperuricosuric calcium nephrolithiasis
- Urinary uric acid > 600mg/24-hour
- Normal serum calcium
- Normal urinary calcium
- Normal urinary oxalate
- Urinary pH > 5.5

Hyperuricosuric calcium nephrolithiasis
- Increased monosodium urate
- Adsorbs inhibitors
- Catalyst for heterogenous nucleation
- Uric acid/ CaOx crystal interaction

Urinary Calculus Disease

Hyperuricosuric calcium nephrolithiasis
- Dietary (85%)
  - Increased purine intake
  - Effective treatment - dietary modification
- Endogenous increased uric acid production
  - Persists despite dietary changes

Hyperuricosuric calcium nephrolithiasis
- Treatment
  - Dietary dependent
    - Change diet
  - Dietary independent
    - Allopurinol: 300 mg/day
    - Potassium citrate as an alternative
Urinary Calculus Disease

Hypercalciuria
Hyperuricosuria
**Hyperoxaluria**
Hypocitraturia

Hyperoxaluric calcium nephrolithiasis
- Increased oxalate absorption
  - Inflammatory bowel disease
  - Excessive vitamin C (>2gm/d)
  - Excessive oxalate intake
  - Endogenous overproduction

Urinary Calculus Disease

Hyperoxaluric calcium nephrolithiasis
- Endogenous overproduction - rare
- Nephrocalcinosis and renal failure
- Liver and renal transplant - effective treatment
  - Type 1
    - 2-oxoglutarate:glyoxylate carboligase
  - Type 2
    - L-glyceric dehydrogenase

Intestinal malabsorption of bile and fat
- Increased intraluminal fat
- Fat + calcium forms soap complex
- Decreased free intra-luminal calcium
- Increased free intra-luminal oxalate
- Increased oxalate absorption
Urinary Calculus Disease

**Hyperoxaluric calcium nephrolithiasis**
Urinary oxalate levels increased
(> 40mg/24 hours)
Urinary calcium levels decreased
(< 100mg/24 hours)
Serum calcium may be low or low/normal

**Treatment**
- Limit dietary oxalate - easier with animals
- Increased fluid intake
- Change dietary fat to medium chain triglycerides
- Oral calcium or magnesium

**Urinary Calculus Disease**

**Hypocitraturic calcium nephrolithiasis**
Anything associated with a metabolic acidosis
- Diarrhea
- Dehydration
- RTA type 1
- Diuretics

**Urinary Calculus Disease**

**Hypocitraturia**
**Hypercalciuria**
**Hyperuricosuria**
**Hyperoxaluria**
**Hypocitraturia**
Hypocitraturia

Isolated defect 18.6%
  + Hyperoxaluria  2.9%
  + Hypercalciuria  1.9%
  + Hyperuricosuria  2.3%
  + Multiple defects  2.2%

Total 27.8%

Renal Citrate Handling

Normal Proximal Tubular Cell

Renal Citrate Handling

Acidotic Proximal Tubular Cell

Renal Citrate Handling

Alkalotic Proximal Tubular Cell
Inhibitors: Citrate
Tablet citrate supplements
Urocit - K (10 mEq)
  K-citrate 1080 / 10 mEq

Tablets have a wax matrix
  Frequently found in stool
  Reasonable bowel transit
  Complete absorption

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