Management of Urolithiasis in Obese Patients

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Disclosures

- SAB: Novome, Alnylam, Synlogic, Orfan
Management

- Medical/Dietary Management
- Surgical Management
Medical and Dietary Management

- Epidemiology
- Stone Composition
- 24 hour urine
Epidemiology: Nephrolithiasis

- Nephrolithiasis affects nearly 11% of men and 7% of women in the United States
- National Health and Nutrition Examination Survey (NHANES)
  - NHANES II (1976-1980): 3.8%
  - NHANES III (1988-1994): 5.2%
  - NHANES (2007-2010): 8.8%
- Men>Women
- Caucasians>African Americans
Epidemiology: Obesity
Obesity Trends* Among U.S. Adults
BRFSS, 1985

(*BMI ≥30, or ~ 30 lbs overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
BRFSS, 1986

(*BMI ≥30, or ~ 30 lbs overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
BRFSS, 1987
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Obesity Trends* Among U.S. Adults
BRFSS, 1988

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BRFSS, 1995

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Obesity Trends* Among U.S. Adults
BRFSS, 2001

(*BMI ≥30, or ~ 30 lbs overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
BRFSS, 2002

(*BMI ≥30, or ~ 30 lbs overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults

BRFSS, 2003

(*BMI ≥30, or ~ 30 lbs overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
BRFSS, 2004

(*BMI ≥30, or ~ 30 lbs overweight for 5’ 4” person)
Obesity Trends* Among U.S. Adults
BRFSS, 2005

(*BMI ≥30, or ~ 30 lbs overweight for 5’ 4” person)
Age-adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

**Obesity (BMI ≥30 kg/m²)**
- 1994
- 2000
- 2013

**Diabetes**
- 1994
- 2000
- 2013

Obesity and Stone Disease

- Relative Risk for BMI>30 versus BMI 21-22.9
  - HPFS RR 1.33
  - NHS I RR 1.90
  - NHS II RR 2.09

<table>
<thead>
<tr>
<th>Waist Circumference</th>
<th>NHS1</th>
<th>NHS2</th>
<th>HPFS</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 34 INCHES</td>
<td>1.24</td>
<td>0.98</td>
<td>1.23</td>
</tr>
<tr>
<td>34-36 INCHES</td>
<td>1.44</td>
<td>1.37</td>
<td>1.21</td>
</tr>
<tr>
<td>37-39 INCHES</td>
<td>1.49</td>
<td>1.71</td>
<td>1.42</td>
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<tr>
<td>40-43 INCHES</td>
<td>1.71</td>
<td>1.94</td>
<td>1.71</td>
</tr>
<tr>
<td>&gt; 43 INCHES</td>
<td>1.48</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Body Weight and Stone Disease

Diabetes and Stone Disease

Hypertension and Stone Disease

OR Hypertension in those with Kidney Stone

- NHS 1: 1.24
- HPFS: 1.29

CARTIA Study: Carotid Artery Atherosclerosis and Stone Disease

- CARTIA observational study
- 5,115 ages 18-30 years
- Follow-up at 2, 5, 7, 10, 15 and 20 years
- Carotid artery IMT (B mode ultrasound)
- 3.9 % reported kidney stone at 20 years

Myocardial Infarction and Stone Disease

- Olmsted County Minnesota
- 4564 stone formers matched to 10,860 controls
- Mean follow-up 9 years
- Adjustment for other medical co-morbidities

Metabolic Syndrome

• Definition:
  – Contains at least 3 of the 5 conditions
    • Central (abdominal obesity)
    • Elevated Blood Pressure
    • Elevated Fasting Plasma Glucose
    • High Serum Triglycerides
    • Low high density lipoprotein (HDL) levels
Metabolic Syndrome and Stone Disease

• NHANES III
  – Self reported stone risk 2x higher in those with metabolic syndrome
  – Correlates with number of factors
    • 0 factors: 3.7%
    • 3 factors: 7.5%
    • 5 factors: 9.8%

Medical and Dietary Management

- Epidemiology
- Stone Composition
- 24 hour urine
Obesity and Stone Composition

- Most associate uric acid stone with obesity
- Still calcium oxalate in most common

Medical and Dietary Management

- Epidemiology
- Stone Composition
- 24 hour urine
Obesity and 24 Hour Urine

- Development of uric acid stones is due to a low urinary pH
- Obese individuals tend to excrete more calcium
  - Dietary indiscretions including increased sodium consumption
- Oxalate excretion directly correlates with BMI
Urinary Oxalate Excretion and Obesity

• Positive correlation with **body weight**
• Positive correlation with **body surface area**
• Positive correlation with **obesity**
• Positive correlation with **BMI**

Ekeruo et al. J Urol. 2004
Obesity and 24 Hour Urine

- \(\downarrow\) Citrate Excretion
- \(\downarrow\) Urine pH
- \(\uparrow\) Oxalate Excretion
- \(\uparrow\) Uric acid
- \(\uparrow\) Calcium Excretion

Obesity and 24 Hour Urine

Calcium mg per 24 hours


Oxalate mg per 24 hours


Uric acid mg per 24 hours


Urine pH

- Low urine pH is thought to be due to defective production of ammonium in the proximal tubule.
- This metabolism is attenuated with insulin resistance.
- Results in an increase in net acid excretion and a reduction in urine pH
Work at UAB/UTSW

589 stoneformers
Wood et al. Reviews in Urology. 2019

900 CaOx stoneformers
from UTSW and UAB
<table>
<thead>
<tr>
<th>BMI 18.5 to &lt; 25 kg/m²</th>
<th>BMI 30 to 45 kg/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>(n=311)</td>
<td>(n=238)</td>
</tr>
<tr>
<td>24-hr Urinary Oxalate (mg/day)</td>
<td>30 ± 10</td>
</tr>
</tbody>
</table>
Animal Studies at UAB

A

24-hr Urinary Oxalate (µg)

P = 0.004

NFD HFD

B

24-hr Urinary Glycolate (µg)

P < 0.0001

NFD HFD
Animal Studies at UAB
**Figure** 24-hr urinary $^{13}$C$_2$-oxalate excretion after subcutaneous bolus injection of 2 μmoles $^{13}$C$_2$-glycolate in mice after 10 weeks feeding of either a 17% kcal fat diet (LFD) or 45% kcal fat diet (HFD). $^{13}$C$_2$-oxalate was measured by IC/MS.
**Figure** Correlation between 24-hr urinary oxalate excretion and BMI (Panel A), waist circumference (Panel B) and waist to hip ratio (Panel C) of healthy subjects on a low oxalate controlled diet.
Figure Correlation between 24-hr urinary glycolate excretion and BMI (Panel A), waist circumference (Panel B) and waist to hip ratio (Panel C) of healthy subjects on a low oxalate controlled diet.
Urinary oxalate excretion

Dietary oxalate

Endogenous Oxalate Synthesis

Hydroxyproline
Glyoxylate
Glycine
Glycolate
Other/Unknown?

Ascorbic acid

CaOx Kidney Stone Formers

Diet

Oxalate precursors

Urinary oxalate excretion

Dietary oxalate
Medical and Surgical Management

- Interventions
- Surgical Issues
- Conclusions
Interventions: Guideline Statement

- Clinicians should recommend to all stone formers a fluid intake that will achieve a urine volume of at least 2.5 liters daily. (Standard; Evidence strength: Grade B.)

Intervention: Fluid Intake

Relative Risk of Stone

Curhan et al. Annals of Internal Medicine, 126:497, 1997 (NHS I)
Interventions: Uric Acid Stone and Dissolution Therapy

• Hydration
• pH manipulation between 6.0-7.0
  – Potassium Citrate 20mEq BID
  – Sodium Citrate 30mEq BID
  – Sodium Bicarbonate
• pH diary
• Allopurinol for hyperuricosuric states
Intervention: Guideline Statement

• Clinicians should counsel patients with calcium stones and relatively high urinary calcium excretion to limit sodium intake and consume 1000-1200 mg of dietary calcium per day. (Standard; Evidence Strength: Grade B)
Intervention: Limit Salt, Normal Calcium

• Increased salt, increases urinary calcium and decreases urinary citrate

  Sakhaee et al. Journal of Urology, 150:310, 1993

• WHI observational study, sodium intake divided into quintiles

• Risk increased 61% in highest quintile


Intervention: Guideline Statement

• Clinicians should counsel patients with calcium oxalate stones and relatively high urinary oxalate to limit intake of oxalate-rich foods and maintain normal calcium consumption (expert opinion)
Vitamin C and Stone Disease

- 1-2 grams per day to CaOx stoneformers
- Increases oxalate excretion 33-61%
- Increases risk of stone formation with >1 gram per day

Intervention: Guideline Statement

• Clinicians should encourage patients with calcium stones and relatively low urinary citrate to increase their intake of fruits and vegetables and limit non-dairy animal protein (expert opinion).
Intervention: Guideline Statement

• Clinicians should counsel patients with uric acid stones or calcium stones and relatively high urinary uric acid to limit intake of non-dairy animal protein (expert opinion).
Surgical Management

- Interventions
- Surgical Issues
- Conclusions
Physiologic Considerations in Obesity

- Functional residual capacity decreased
- Expiratory reserve volume decreased
- Total lung capacity decreased
- Systemic blood pressure increased
- Left ventricular pressure increased
- Right ventricular pressure increased
Preoperative Anesthesia

• 77% prevalence of OSA
  – 131/170 patients
  – Independent of BMI

• Routine screening polysomnography

• 10% change in body weight, 30% change in the apnea-hypopnea index (sleep apnea severity)

Intubation and Obesity

• Difficult intubation rate
  – BMI >35  15.5 %
  – Lean <30  2.2 %

Hiremath. BJA 1998;80:606-11
Atelectasis and Obesity

Anesthesia Interventions

• Pre-induction with PEEP
  – Reduction of atelectasis: 10% controls vs 1.7% PEEP group
  – Increased PaO2: 315 mm Hg controls vs 457 Hg PEEP group

• Awake intubation

Anesthesia Analgesia 2004;98:1491-5

Surgical Issues: Shock Wave Lithotripsy

Journal of Urology, 150:30, 1993
Int. Braz. J of Urol. 31:105, 2005

Surgical Issues: Ureteroscopy


Urology, 60:393, 2002.
Surgical Issues: Ureteroscopic Challenges

• Anesthesia
  – ↓ Vital capacity
  – ↑ Intra-abdominal pressure
  – ↑ Cardiac output

• Positioning
  – Increased risk of DVT and compartment syndrome

• Fluoroscopic Imaging
Surgical Issues: Percutaneous Nephrostolithotomy

- Stone Free Rate:
  - BMI >30: 83.70%
  - BMI <30: 82%

- BMI Categories:
  - n=974
  - n=891

- Stone Type:
  - Non-staghorn: 90.2%
  - Staghorn: 84.2%

6 Series from 1988-2008

Surgical Issues: Prone Position

• ↑ oxygenation than supine
• ↑ pulmonary compliance than supine
• ↑ functional residual capacity than supine
Technical Tips for Obese Patient

- Draping
- Secure sheath
- Extra long access needle
- Extra Long sheaths, nephroscope and rigid grasping devices.
Technical Tips for Obese Patients
Technical Tips for Obese Patient

- Nephrostomy Tube
  - Success with tubeless PCNL has been reported
  - Frequent problems with tube displacement
  - Avoid securing tubes at skin level
  - Double J stent
  - Angiographic catheter
  - Circle-nephrostomy tube

Thanks

Special Thanks to
- P20/K08
- UAB KSRL + Dr. Crivelli
- UTSW