Management and Prevention of Kidney Stones

David Harriman, MD, FRCSC

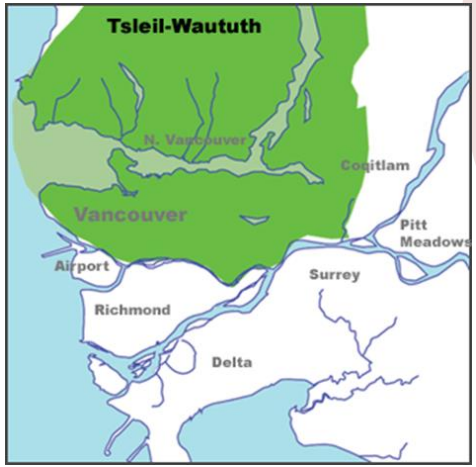
Assistant Professor of Urology

Department of Urologic Sciences

University of British Columbia, Vancouver, BC, Canada

We would like to acknowledge that we are gathered today on the traditional territories of the Musqueam, Squamish and Tsleil-Waututh peoples.

Source: www.johomaps.net/na/canada/bc/vancouver/firstnations/firstnations.html



Objectives

1. Discuss treatment options for urolithiasis

2. Review medical workup of stone disease

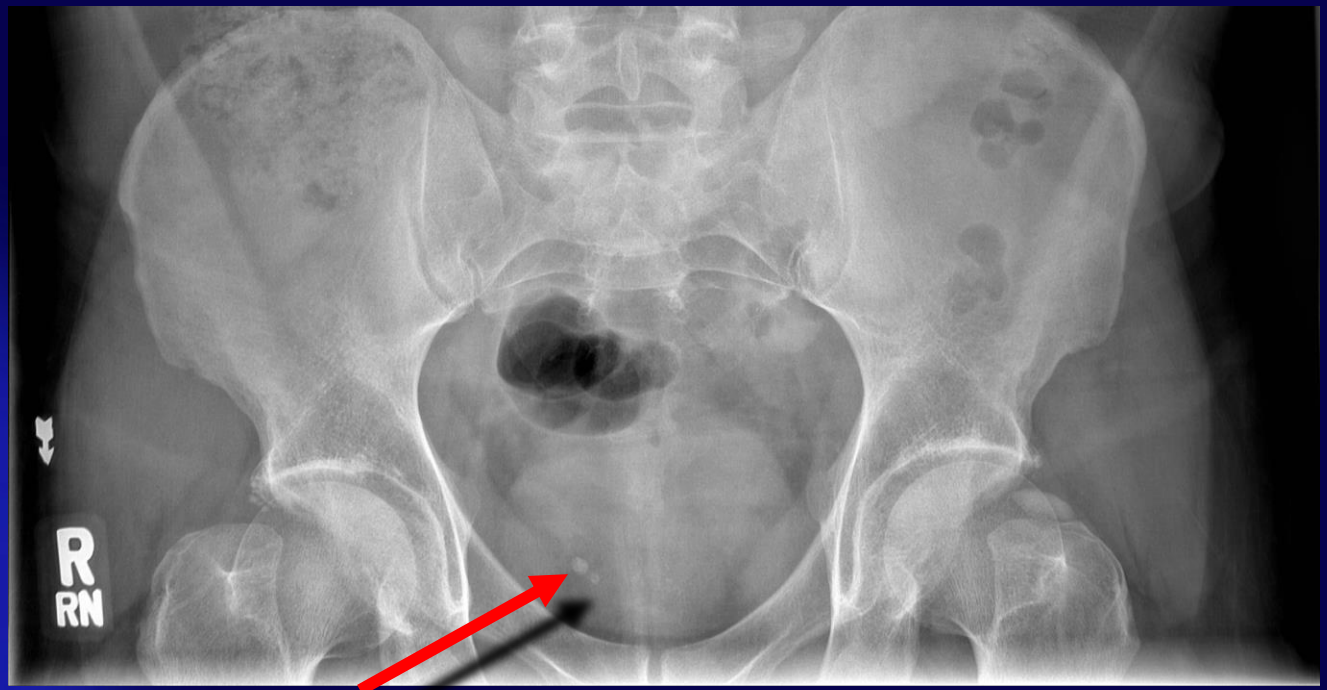
3. Discuss dietary measures for prevention of stone disease

3. Briefly touch on follow-up for stone disease patients

What are the treatment options?

- Observation
- Medical Expulsive Therapy (MET)
- Shock Wave Lithotripsy (SWL)
- UReteroScopy (URS)
- Percutaneous NephroLithotomy (PNL)

Ureteral Stones - Observation



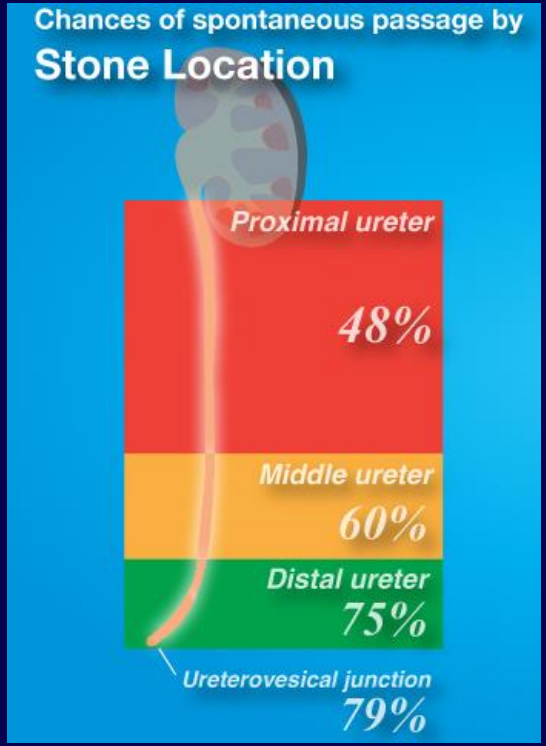
- Right ureterovesical junction stone

Ureteric Stones

- Spontaneous passage?

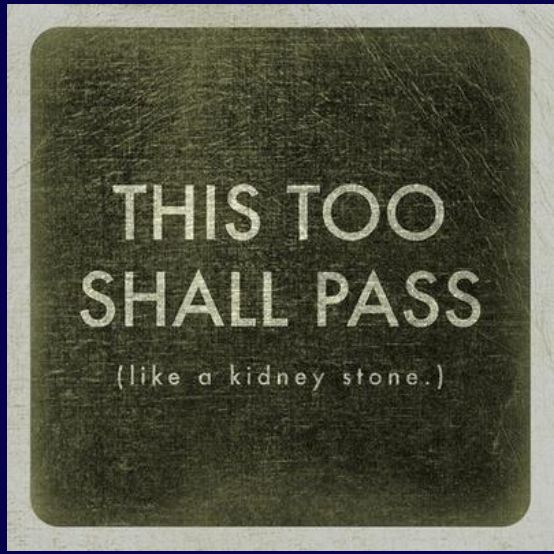
Size	Likelihood
4mm or less	90%
5-7mm	50%
8mm or larger	20%

- Pharmacologic aid in spontaneous passage?
  - Alpha blockers: Tamsulosin
- Other aids?
  - Sexual activity

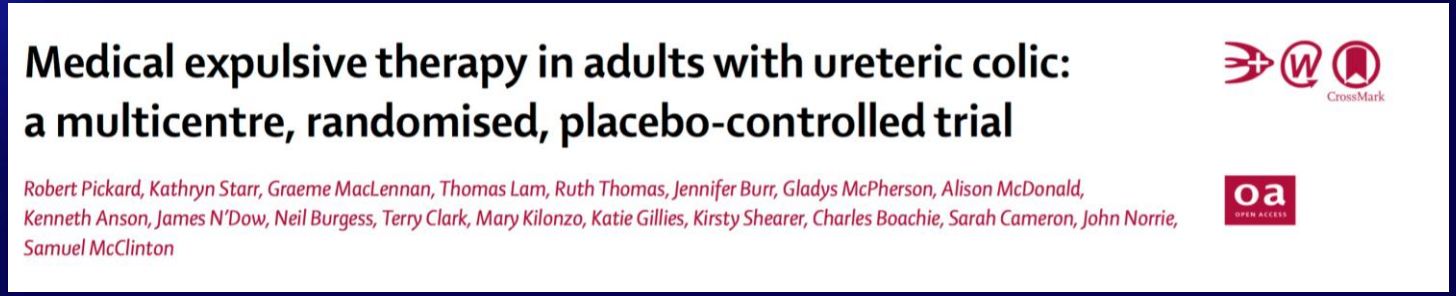


Medical Expulsive Therapy

- Hydration + Analgesia + α-blocker (Tamsulosin)
- Small stones <6-8mm, no infection, non-solitary kidney, no significant obstruction
- Up to 4 wk trial, short interval imaging + close follow-up



Schade GR *Prim Care Clin* 2010
Teichman JM *NEJM* 2004

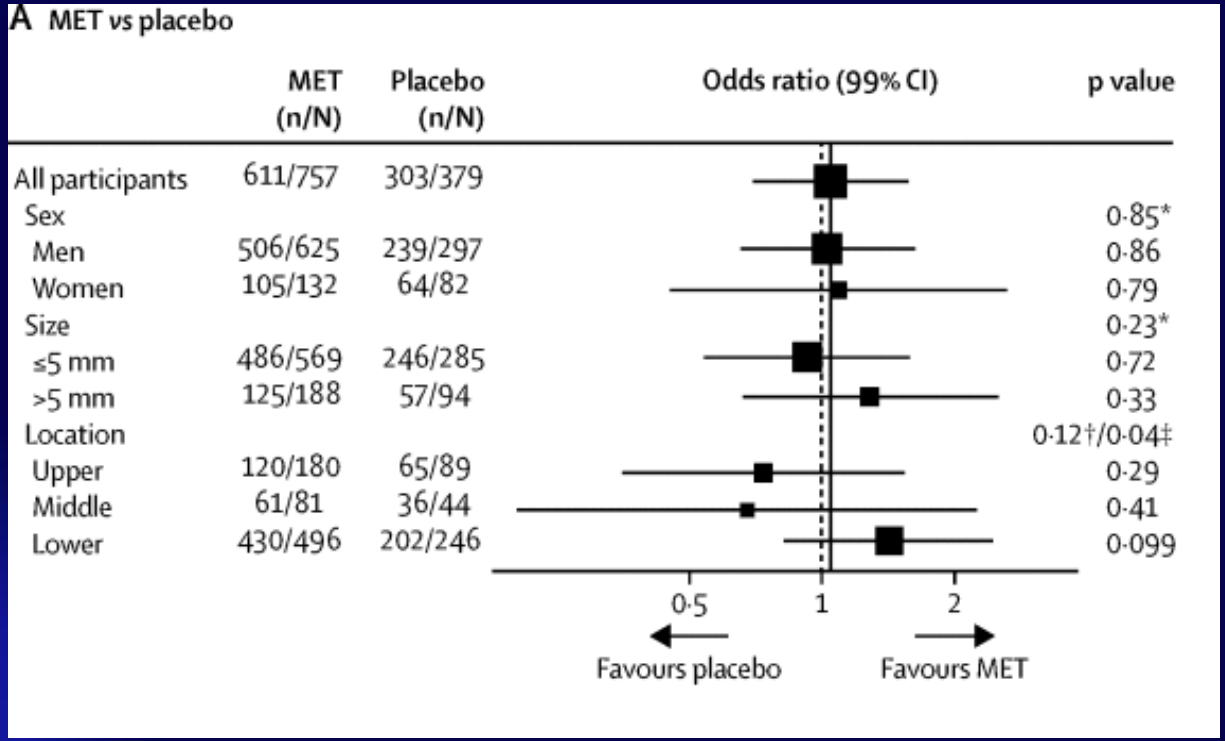


Medical expulsive therapy in adults with ureteric colic: a multicentre, randomised, placebo-controlled trial

Robert Pickard, Kathryn Starr, Graeme MacLennan, Thomas Lam, Ruth Thomas, Jennifer Burr, Gladys McPherson, Alison McDonald, Kenneth Anson, James N'Dow, Neil Burgess, Terry Clark, Mary Kilonzo, Katie Gillies, Kirsty Shearer, Charles Boachie, Sarah Cameron, John Norrie, Samuel McClinton

- Multi-centre, randomized, placebo-controlled for single ureteral stone on CT ≦ 10mm
- 24 hospitals in UK. 4 weeks of:
  - Tamsulosin: 0.4 mg
  - Nifedipine: 30 mg
  - Placebo
- Primary endpoint: need for intervention

Lancet 2015:386:341-9



- MET not effective at decreasing the need for further treatment to achieve stone clearance at 4 weeks

Lancet 2015:386:341-9

Criticisms

- Surrogate outcome– ie. no imaging for outcome
- "*We considered having imaging evidence of stone passage as a trial outcome, in common with other studies, but rejected it for two main reasons*"
  - CT-KUB- too much radiation/$.
  - KUB and U/S not sensitive enough
- All stone sizes included (75% <5mm)
  - *Small stones—that are likely to pass spontaneously anyways—can we make a difference?
- Is 4 weeks too premature?
- Would result have been same if outcome was confirmed stone passage or radiologic confirmation?

Lancet 2015:386:341-9

[Intervention Review]

Alpha-blockers as medical expulsive therapy for ureteral stones

- For ureteric stones:
  - More stone passage (up to 65%)
  - Less analgesia
  - Shorter time to passage (10-35%)
  - Less admission to hospital
  - Seems to be more effective for larger stones (>5 mm)

  - Need for surgery similar to no MET, increased medication AEs

Campschroer et al. Cochrane Review. 2018.

CUA GUIDELINE

CUA Guideline: Management of ureteral calculi

Michael Ordon, MD, FRCSC;[*] Sero Andonian, MD, FRCSC;[†] Brian Blew, MD, FRCSC;[§] Trevor Schuler, MD, FRCSC;[¥] Ben Chew, MD, FRCSC;[#] Kenneth T. Pace, MD, FRCSC[*]

Recommendation:

Medical expulsive therapy with alpha-receptor antagonists potentially shortens the duration and increases the likelihood of spontaneous st one passage. Consideration should be given to offering it to patients with distal ureteral stones less than 10mm in size (Level of Evidence 1a, Grade A).

CUAJ, 2015

Can Sexual Intercourse Be an Alternative Therapy for Distal Ureteral Stones? A Prospective, Randomized, Controlled Study

Omer Gokhan Doluoglu, Arif Demirbas, Muhammed Fatih Kilinc, Tolga Karakan, Mucahit Kabar, Selen Bozkurt, and Berkan Resorlu

- ≦6mm distal ureteral stones, 90 males
- Group 1: Rx: Sex 3-4 times a week
- Group 2: Rx: tamsulosin 0.4 mg/d
- Group 3: analgesics- controls

UROLOGY 86: 19-24, 2015.

Sex and stones Results

Table 1. Overall results	Sex	Tamsulosin	Placebo	
	Group 1	Group 2	Group 3	*P* Value
Expulsion rate (%) after 2 wk	83.9	47.6	34.8	.001*
Expulsion rate (%) after 4 wk	93.5	81	78.3	.23
Expulsion time (d), mean ± SD	10 ± 5.8	16.6 ± 8.5	18 ± 5.5	.0001*
Need for analgesic (times, injection), mean ± SD	1.04 ± 0.5	1.8 ± 1.1	2.3 ± 1.04	.001*

- Theory: Inc'd Nitric Oxide (NO) from sexual stimulation
  - Leads to ureteral relaxation
- Compliance? Only 6% lost to f/u (sex) vs 23% in control groups

UROLOGY 86: 19-24, 2015.

Meta-analysis of the efficacy of sexual intercourse for distal ureteric stones

Evaluation of the efficacy of sexual intercourse on distal ureteral stones in women: a prospective, randomized, controlled study

Compared with placebo, sexual intercourse exhibited greater efficacy for the treatment of distal ureteral stones, whilst potentially alleviating pain in both men and women.

Xu et al. J Int Med Res. 2019.
Turgut et al. Int Urol Nephrol. 2021.

Case – Renal Stone

- 31 yo woman complains of epigastric abdominal pain – an abdominal US is obtained
  - US shows left lower pole kidney stone – 7 mm
  - KUB – 4 mm radioopaque left kidney stone

- No hematuria or UTIs, no lateralizing discomfort
- Serum Cr = 90 umol/L
- Is this the cause of her pain?

Prospective Long-Term Followup of Patients With Asymptomatic Lower Pole Caliceal Stones

Kubilay Inci,* Ahmet Sahin, Ekrem Islamoglu, Murat T. Eren, Mehmet Bakkaloglu and Haluk Ozen

From Faculty of Medicine, Department of Urology, Hacettepe University, Ankara, Turkey

- Prospective study
- Inclusion criteria: asymptomatic LP calculi
  - 27 renal units; assessed q6months
  - Regular imaging; CT (even years); U/S (odd years); plain KUB
  - Mean f/up 52 months
  - Initial stone size 8.8mm (2-26mm)
- Progression: pain, stone growth, recurrent UTI, gross hematuria
- Result: 9 of 27 renal units had progression; 3 of these required intervention; 18.5% were stone free
- **Conclusion: asymptomatic LP calyceal stones can be safely observed; inform pt of 33% progression rate, 11% risk of intervention**

Journal of Urology 2007

Observation of Kidney Stones
EAU Urolithiasis

Statement	LE
It is still debatable whether kidney stones should be treated, or whether annual follow-up is sufficient for asymptomatic caliceal stones that have remained stable for 6 months.	4

Recommendations	GR
Kidney stones should be treated in case of growth, formation of de novo obstruction, associated infection, and acute or chronic pain.	A*
Comorbidity and patient preference need to be taken into consideration when making treatment Decisions.	C
If kidney stones are not treated, periodic evaluation is needed.	A*

** Upgraded based on panel consensus.*

- Follow up - not uniform; size and location matter
  - VGH - yearly plain KUB + US; low dose CT KUB if worried
  - EAU - 6, 12, 24, 48 months, then every 2-3 years

Follow-Up: Ultrasound vs CT vs KUB

Ultrasound

- Medium price
- Easy to obtain
- No radiation
- Can assess parenchymal thickness and hydronephrosis
- Cons:
  - May miss large stones
  - Magnifies small stones
  - Misses ureteric stones
  - Difficult in obese patients
  - Stone sizes are inaccurate

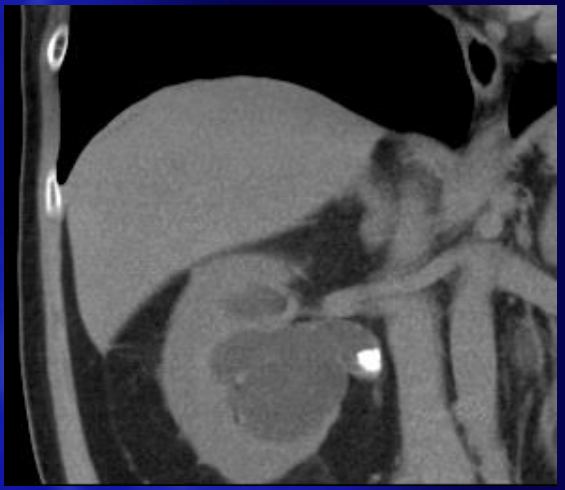
KUB x-ray

- Cheap
- May miss small stones (clinically insignificant)
- Small radiation (~0.6 mSv)
- CANNOT assess hydronephrosis or parenchymal thickness
- Cannot see uric acid or cystine stones, some infection stones
- Sensitivity 57%, specificity 71%
- Overall detection rate 50-70%

CT KUB – Low Dose

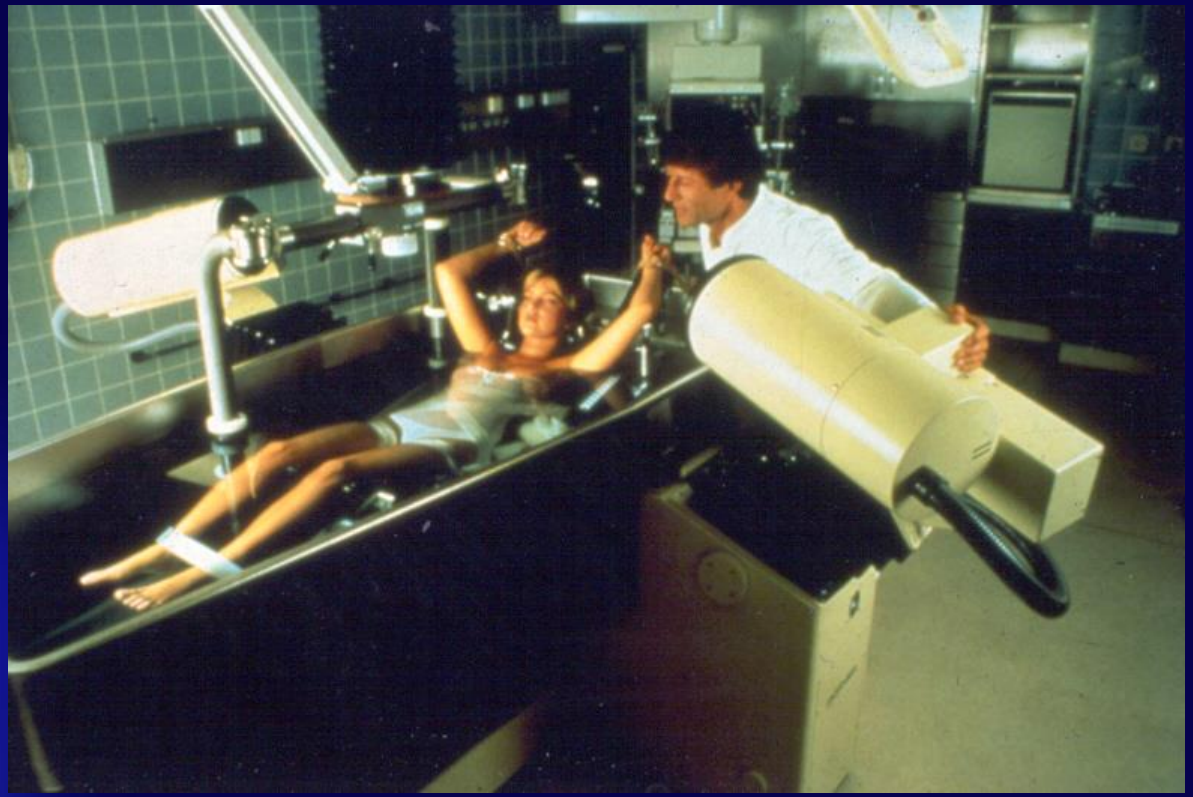
- Most expensive
- Sensitive (99%) and Specific (94%)
- Relatively low radiation (~1 mSv)
- Can assess parenchymal thickness and hydronephrosis
- Can see uric acid, cystine, and infection stones
- Gold standard imaging for stone disease

Indications for active renal stone removal

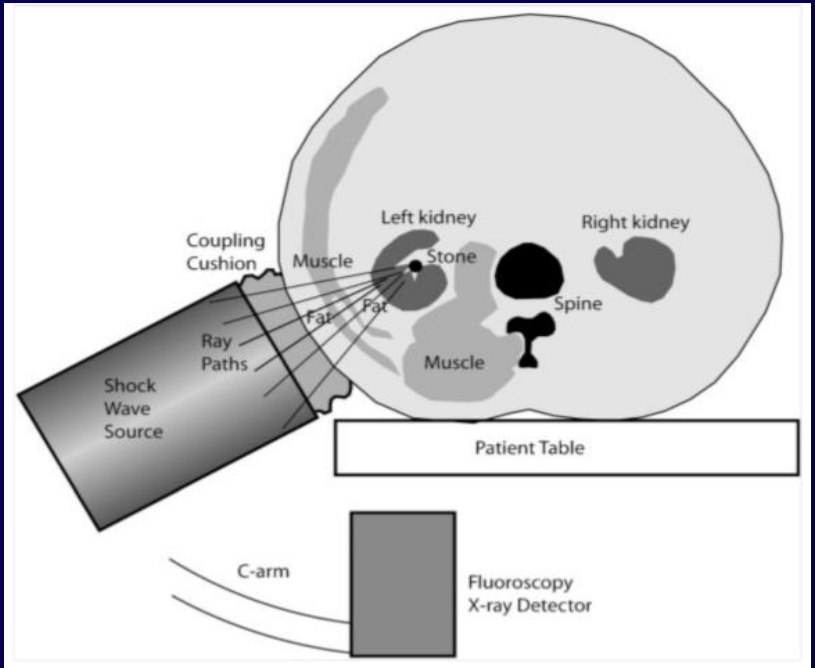


- EAU Urolithiasis Guidelines
  - Stone growth*
  - Stones in high-risk patients for stone formation
  - Obstruction
  - Infection
  - Symptomatic (e.g. pain or hematuria)
  - Stones > 15mm
  - Stones < 15mm if observation is not option of choice
  - Comorbidity
  - Social situation of patient (e.g. profession or travelling)
  - Choice of treatment

ShockWave Lithotripsy (SWL)



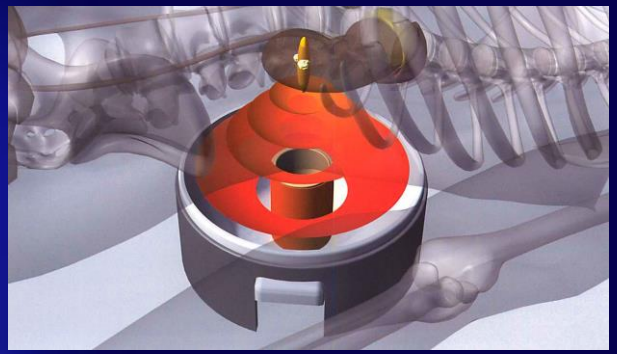
Shockwave Lithotripsy – A Primary Treatment Modality for Urolithiasis

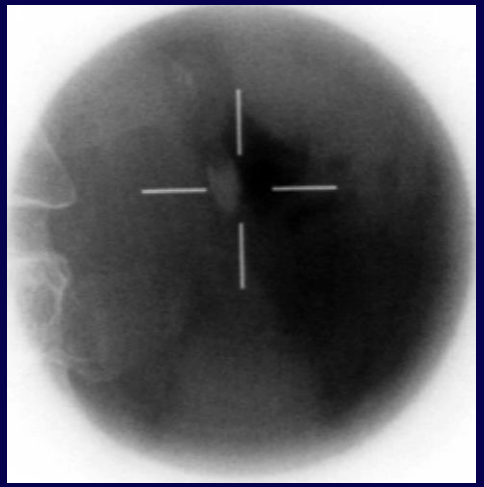


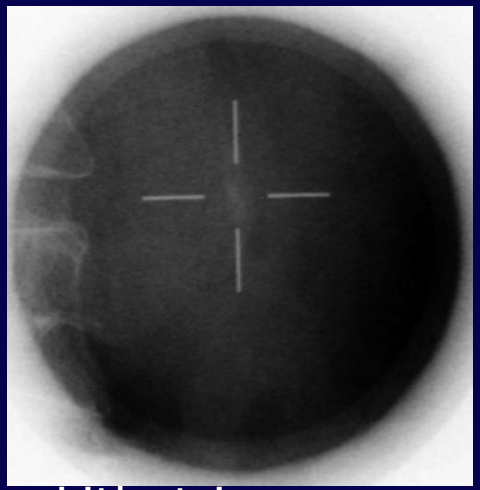
Leighton TG and Cleveland RO: Lithotripsy. Proc Inst Mech Eng Part H-J Eng Med, **224:** 317 (2010).

Effective stone fragmentation can be achieved for calculi <15 mm, but SWL is not free from complications

SWL

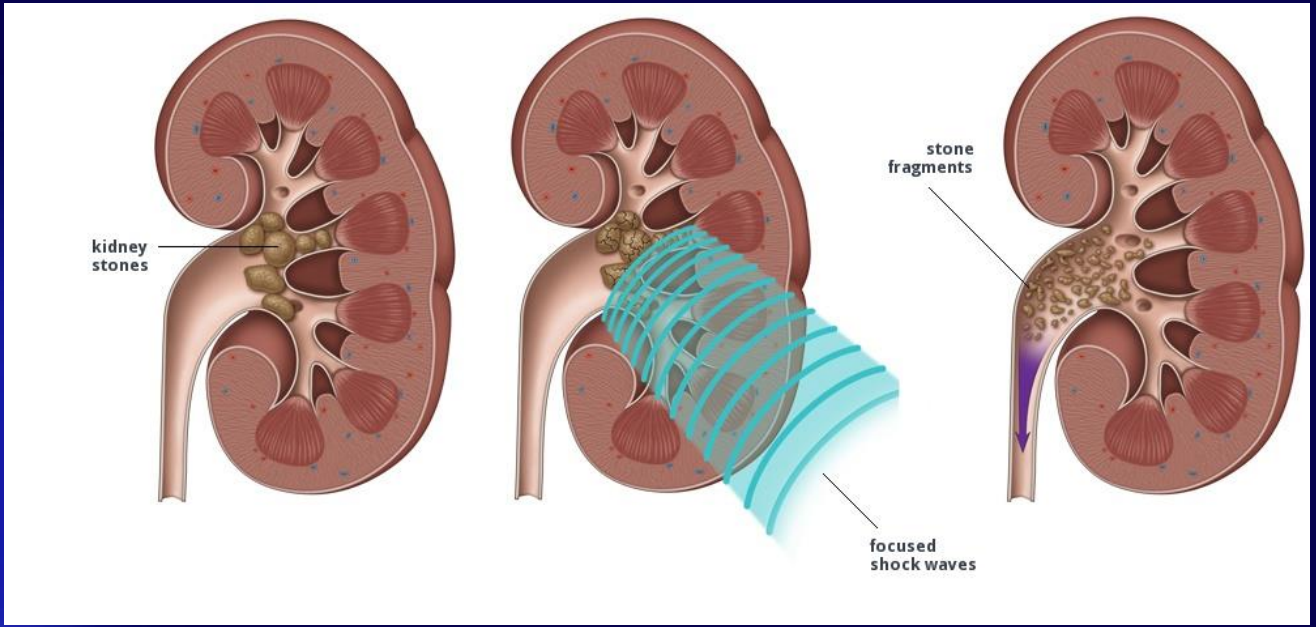


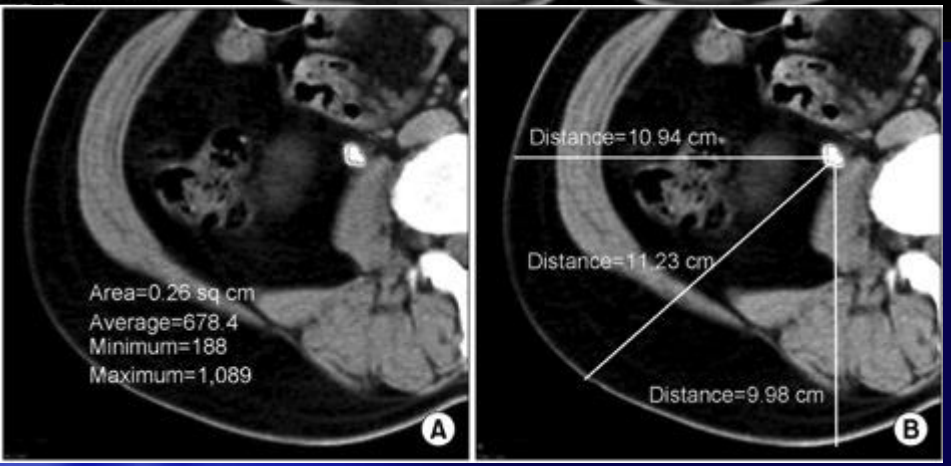




SWL: Extracorporeal Shockwave Lithotripsy

Shockwave Lithotripsy





SWL-Rule 10s

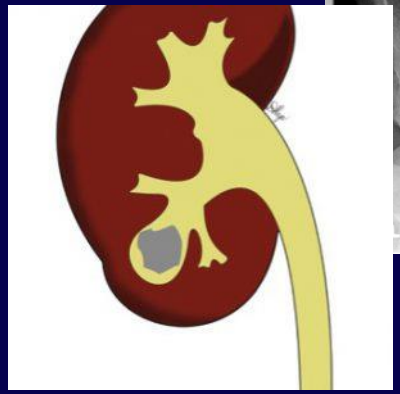
- More successful if:
  - Stone density, HU
    - <1,000 HU
  - SSD: Skin to stone distance
    - <10 cm
  - Stone size
    - <10mm
  - Stone location
    - Not in Lower pole

AUA Guideline Recommendations

- ≤ 20 mm, clinicians may offer SWL or URS.
- >20 mm, clinicians should NOT offer SWL as first-line therapy.
- ”Steinstrasse” (German = “street of stones”)

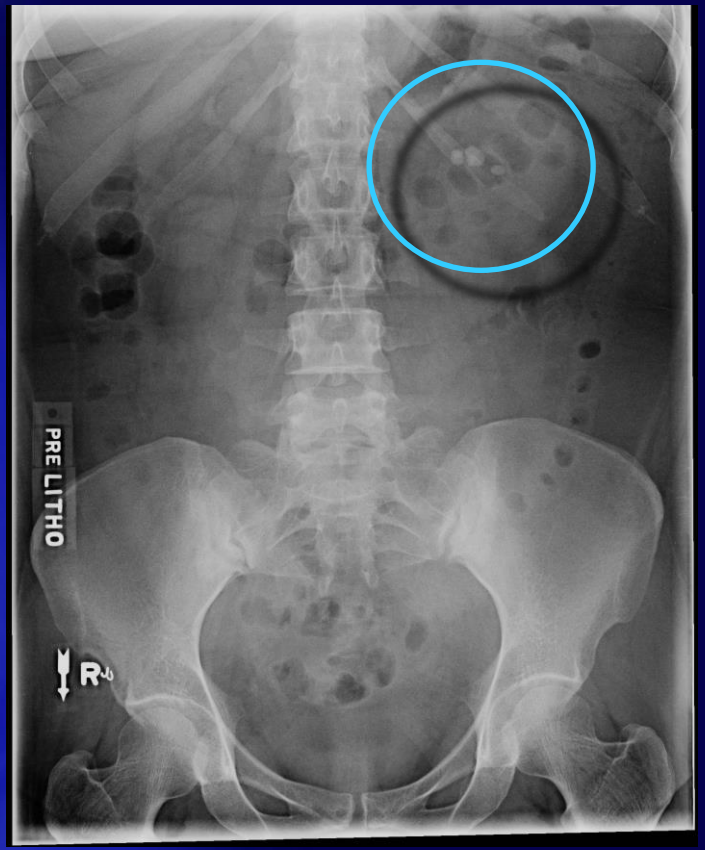
AUA Guideline Recommendations

- SWL or URS to patients with symptomatic ≤ 10 mm lower pole renal stones.
- Should not offer SWL as first-line therapy to patients with >10mm lower pole stones.

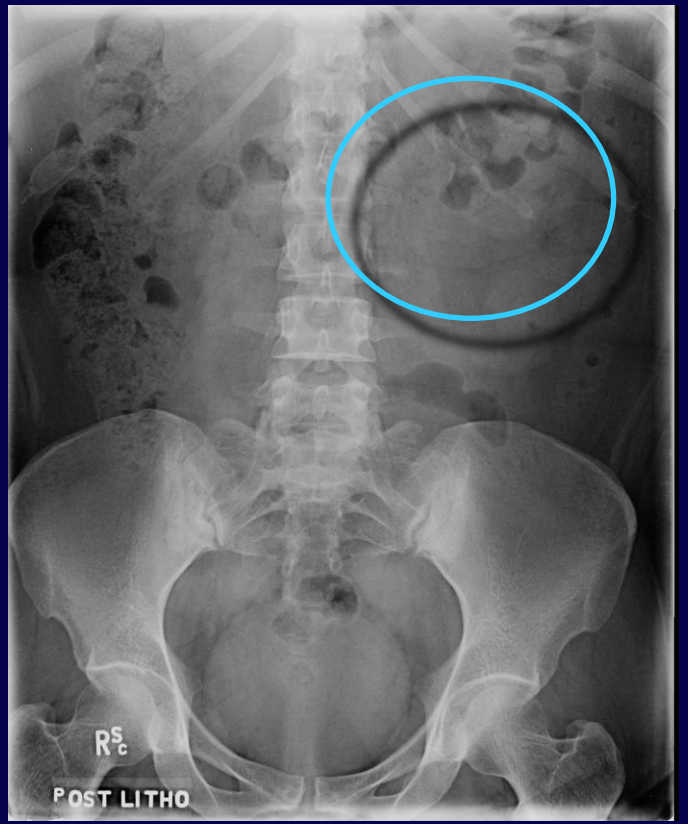


ESWL Successful!

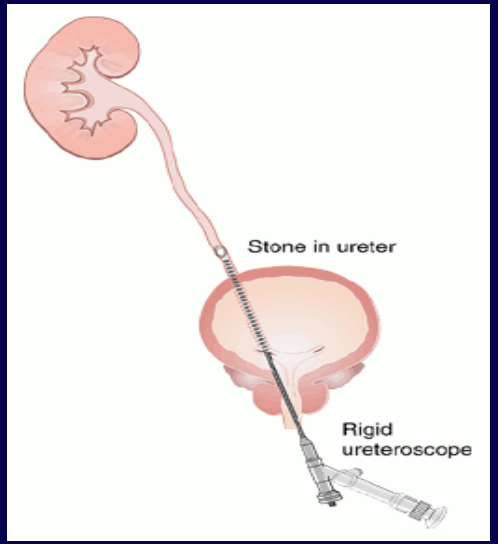
Pre-ESWL

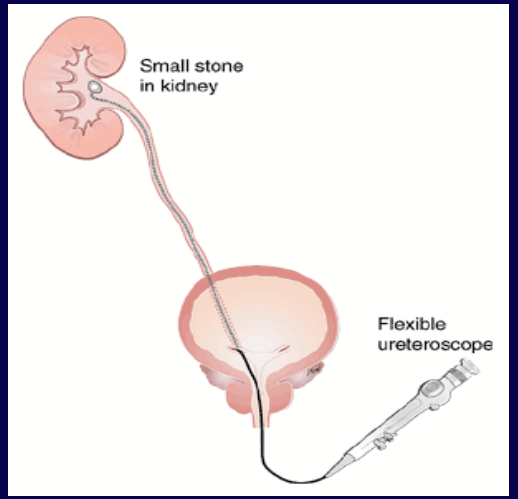


Post-ESWL

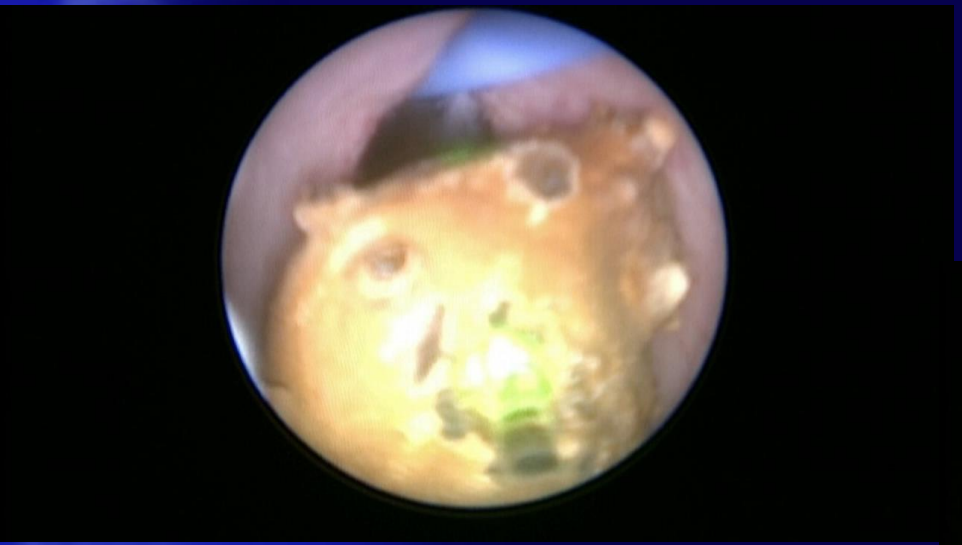


Ureteroscopy

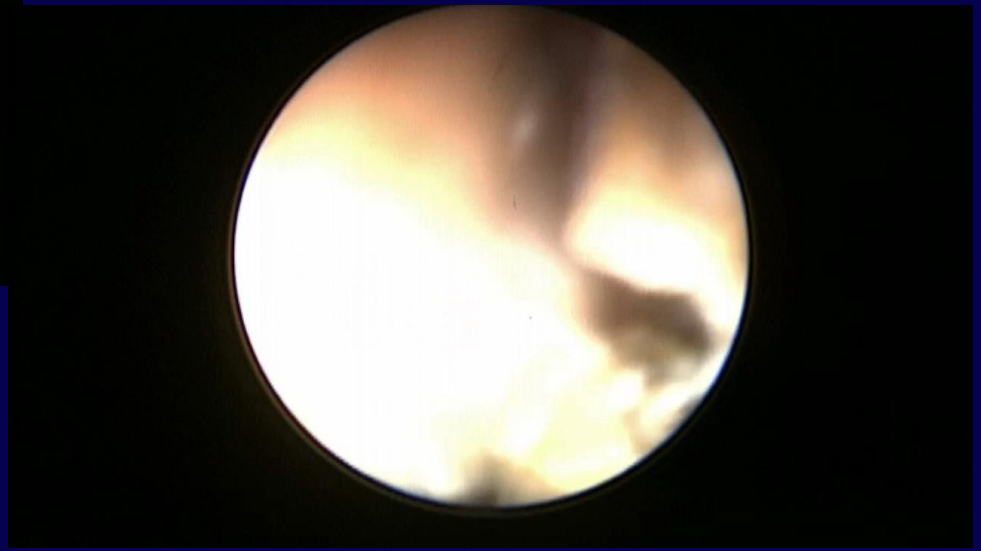




Lasering a stone into fragments

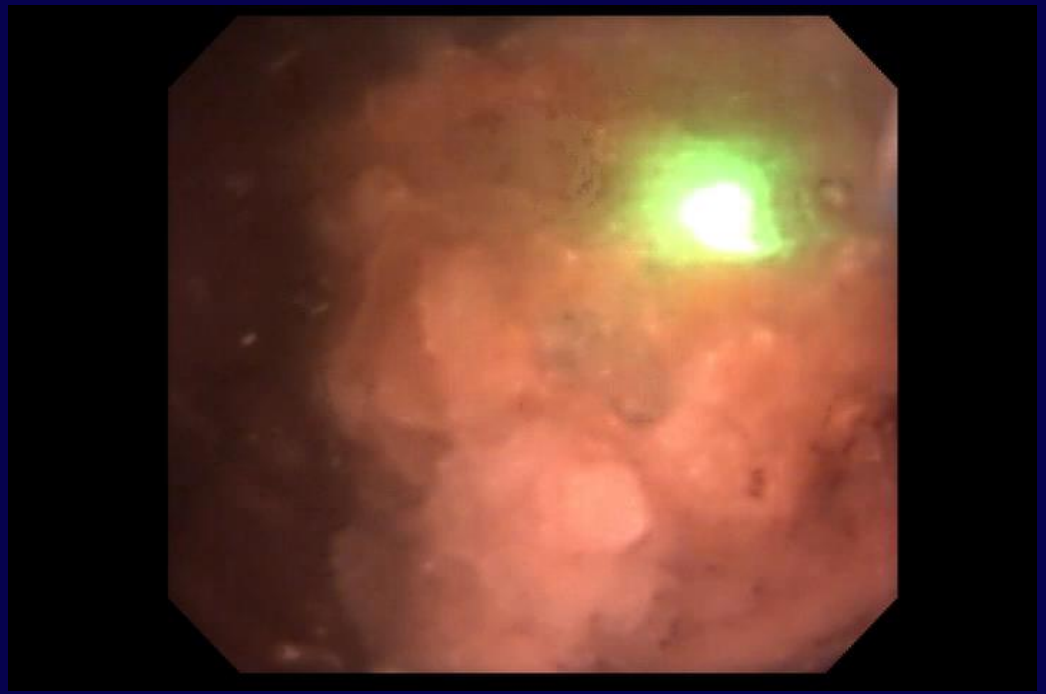


Basketing fragments



Dusting

- Stones are lasered into “dust” that is passed spontaneously

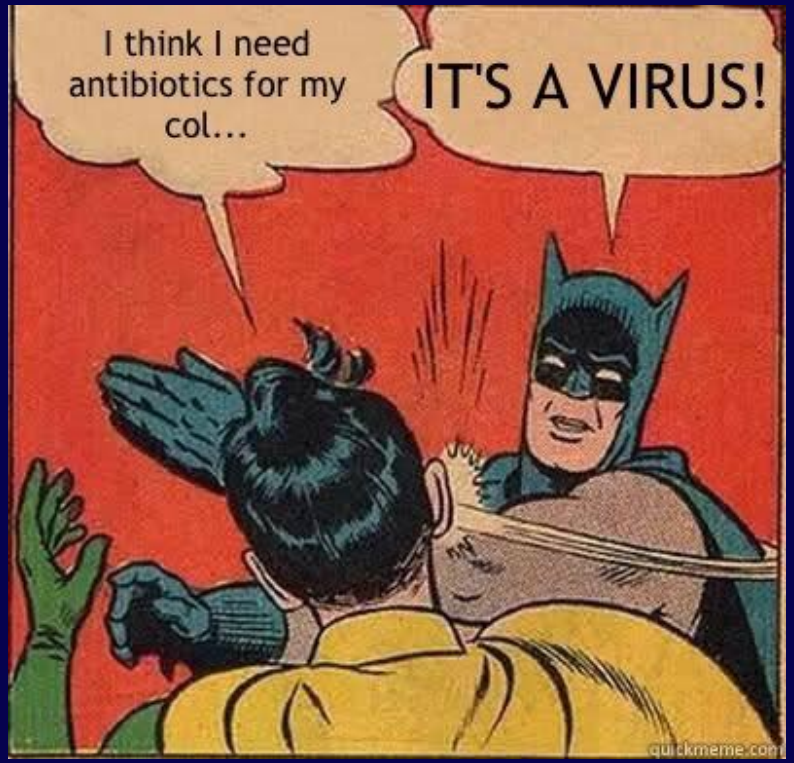


Ureteral stent

- Continues urinary drainage while edema settles down
- Passively dilates the ureter
- Temporary
- 5 days -30 days
- Extraction
  - Self-removal string
  - cystoscopy

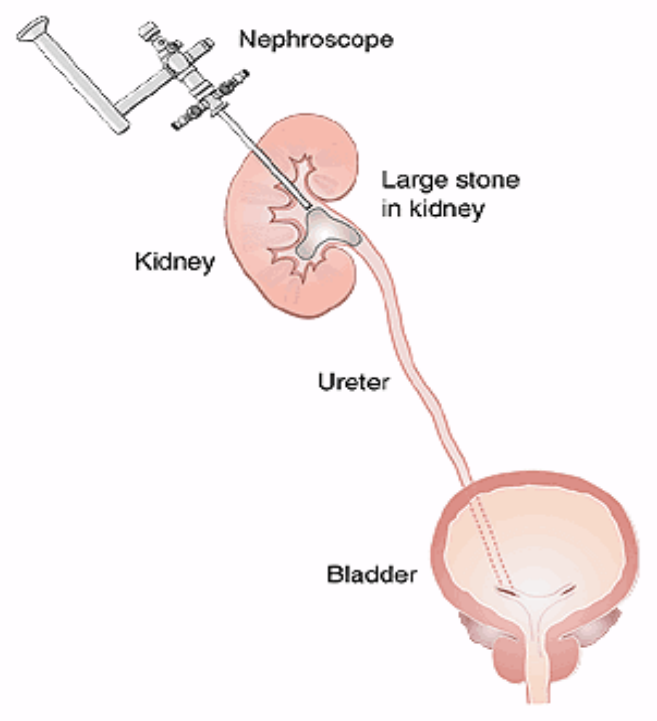
Bad side of Ureteral stents

- Dysuria
- Hematuria
- Flank pain while voiding
- Symptoms like an infection
- Do NOT give Abx unless fever or positive urine culture
- Long-term
  - Infection
  - Encrustation
  - Renal damage



Treatment of stones> 2 cm and Staghorn Calculi?

PCNL: Percutaneous Nephrolithotomy



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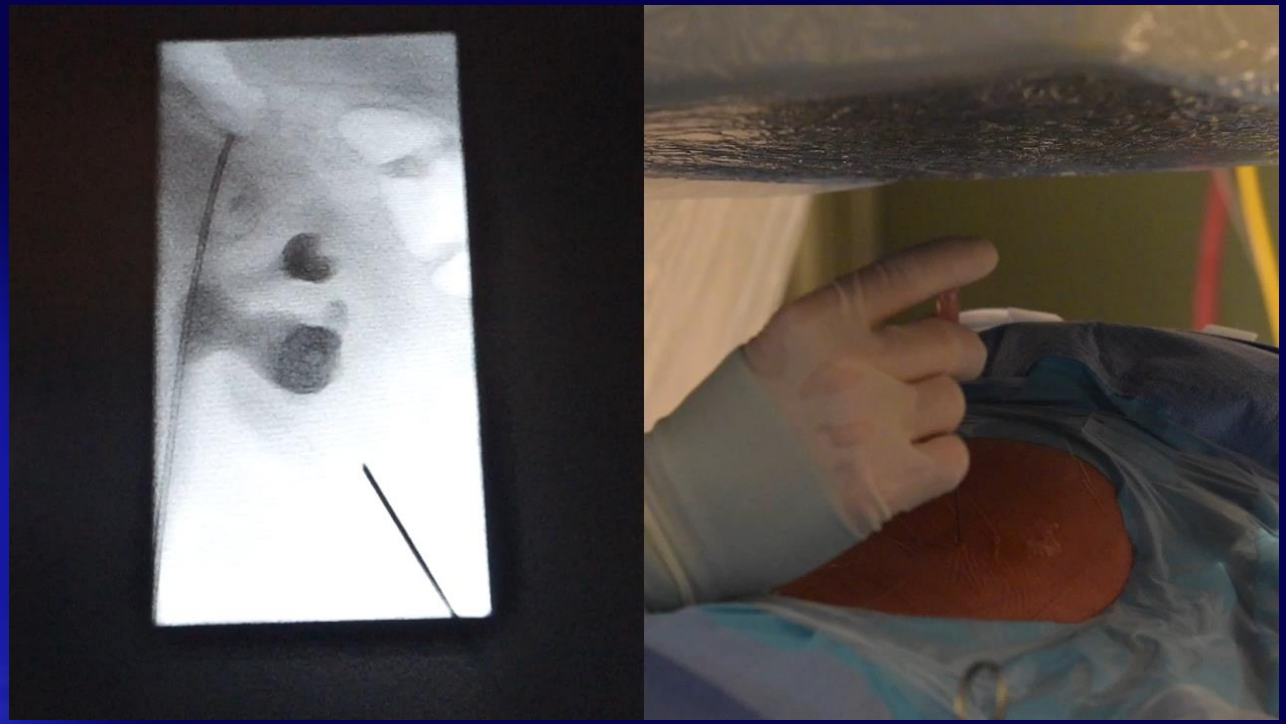
Percutaneous access into the kidney




LIH

Stone Disease Work-Up and Management

- Metabolic evaluation and stone prevention is worthwhile
- Treat the whole patient, not just the stone
- Stones are associated with Metabolic Syndrome
  - Diabetes, Hypertension, Coronary Artery Disease, Obesity
- DASH Diet is good for stones
- Take calcium (especially with oxalate foods)

Update – 2022 Canadian Urological Association guideline: Evaluation and medical management of the kidney stone patient

- Limited Evaluation → All stone patients
  - Bloodwork → Na, K, Cl, HCO3, Cr, Ca
    → UA +/- C&S (including Ph)
    → Stone analysis

- Full Evaluation → If indicated
  - Bloodwork → Cr, Na, K, Cl, Ca, albumin, uric acid, bicarb
    → PTH if Ca high N or elevated
    → Vit D if low/N serum Ca or elevated PTH
    → 2 x 24 hr urine collection: pt on usual diet, off stone meds
    → Volume, Cr, Ca, Na, K, Citrate, Oxalate, UA, Mg, +/- cystine
    → Spot urine: Urine pH, UA, specific gravity
    → Stone analysis

Indications full workup:

1. Multiple, bilateral
2. Recurrent – 2 or more stone episodes
3. Pure calcium phosphate stones
4. Any complicated stone episode that resulted in AKI, sepsis, hospitalization
5. Any stone requiring PNL
6. Child (<18 yo)
7. Non-Calcium stones (cystine, uric acid)
8. Solitary kidney / anatomical abnormality
9. Renal insufficiency
10. Critical occupations (pilot, air traffic controller, police, fireman, military)
11. Systemic Dz associated w/ stones (gout, osteoporosis, bowel dz, hyperPTH, RTA)

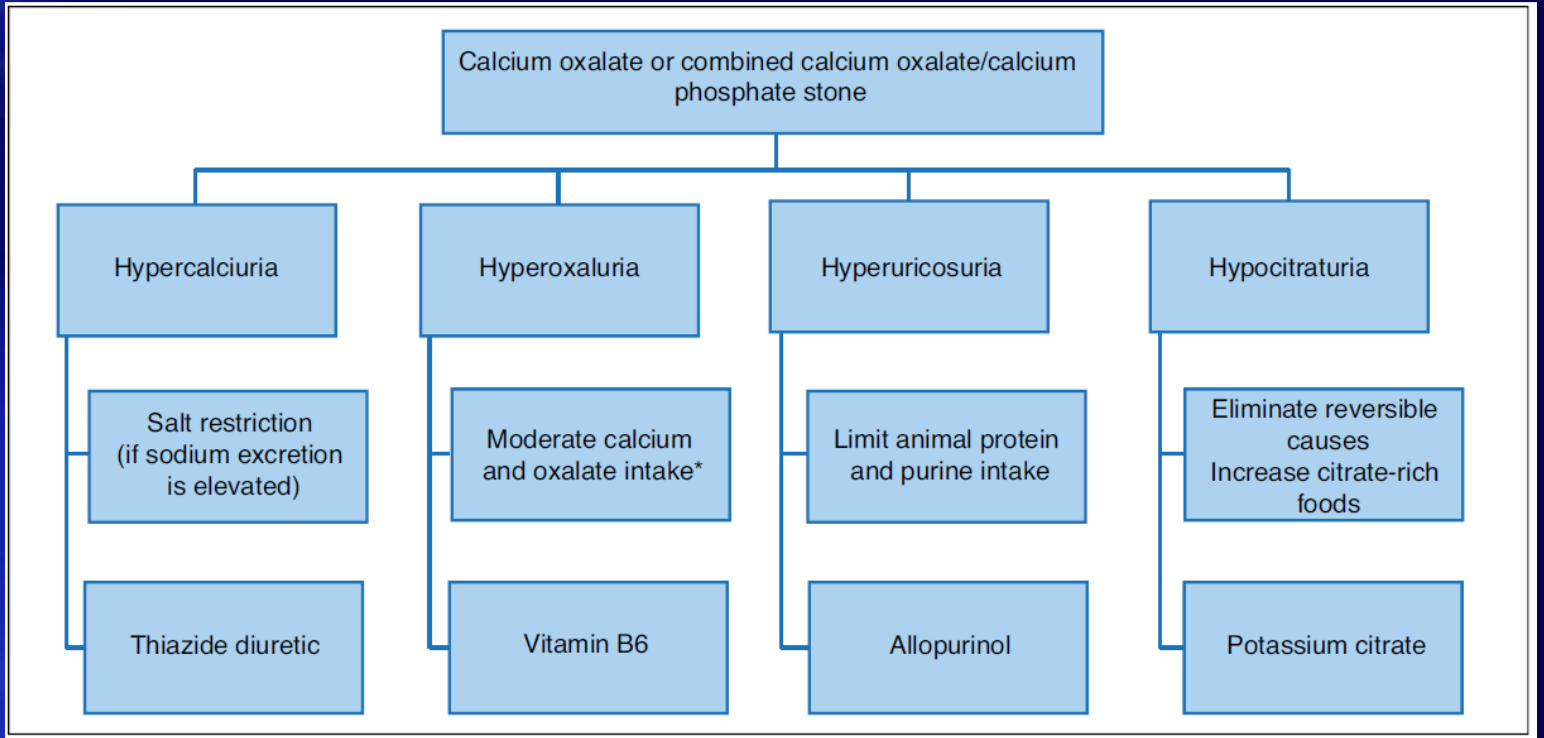
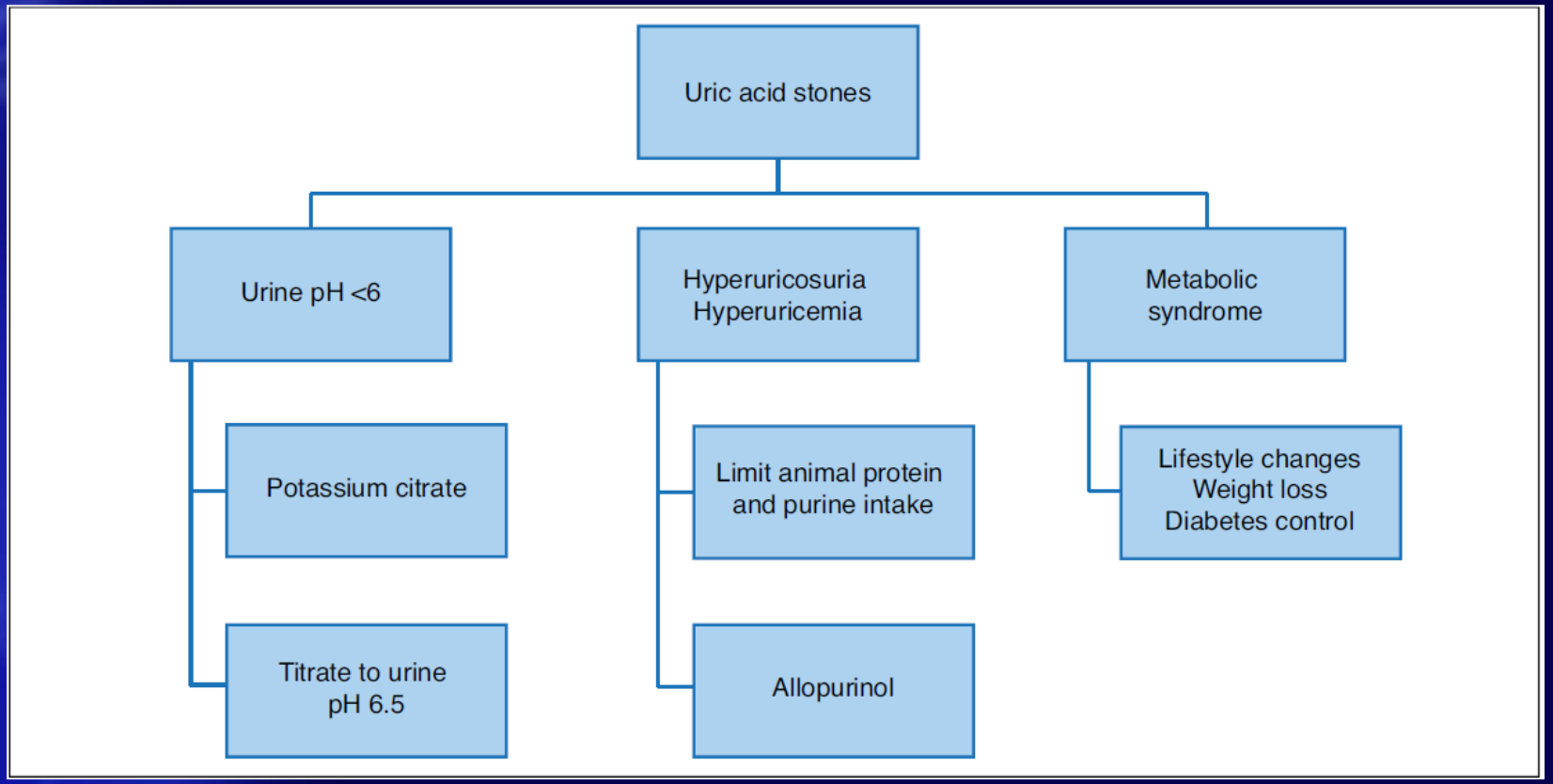
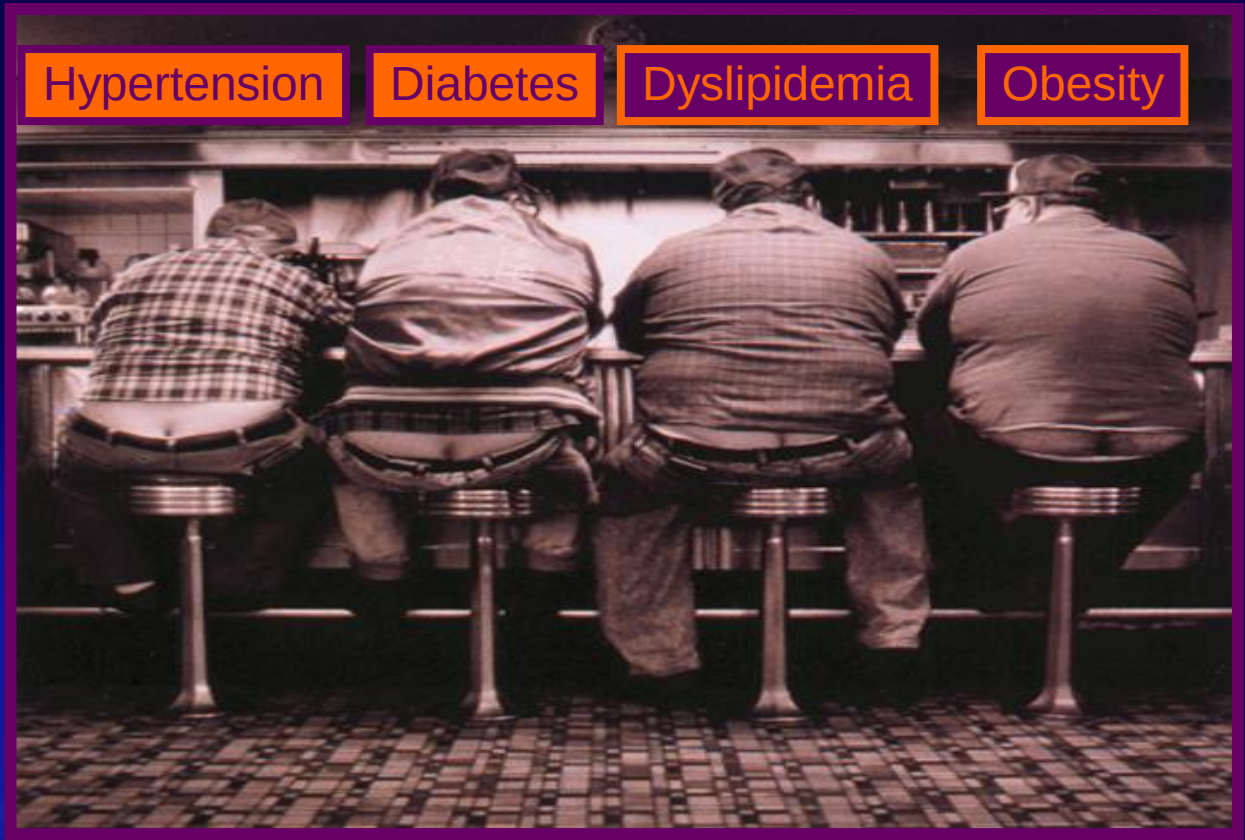


Fig. 1. Specific dietary and medical treatments for patients with calcium oxalate or mixed calcium oxalate/calcium phosphate stones.*Calcium intake 1200 mg daily (with meals), moderation of foods high in oxalate, pair oxalate and calcium-containing foods.


Uric acid stones
Urine pH <6
Hyperuricosuria
Hyperuricemia
Metabolic
syndrome
Potassium citrate
Titrate to urine
pH 6.5
Limit animal protein
and purine intake
Allopurinol
Lifestyle changes
Weight loss
Diabetes control

The Metabolic Syndrome



NHANES III

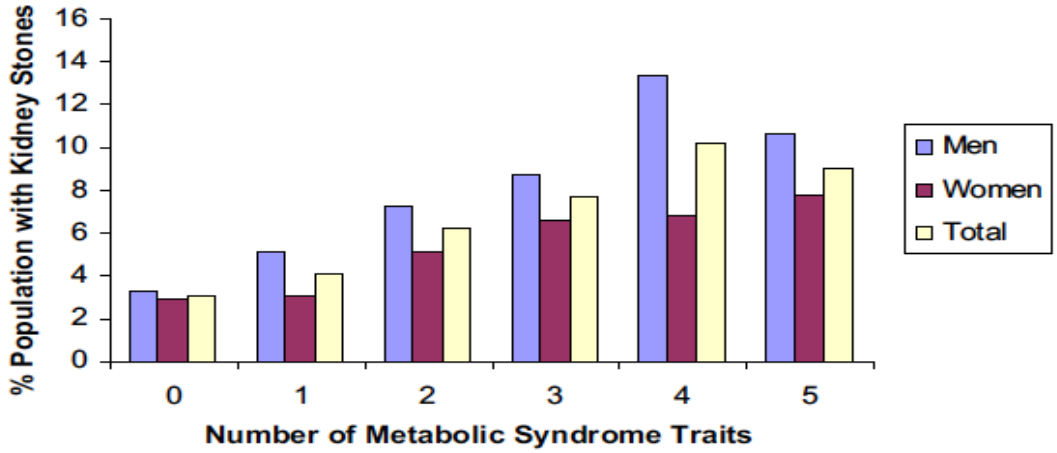


Figure 1. Prevalence of self-reported kidney stone disease by number of metabolic syndrome traits and by sex.

- The more metabolic syndrome traits you have, the higher risk of kidney stone disease
  - **8.8% with metabolic syndrome (OR, 2.13)**
  - 4.3% w/o metabolic syndrome ($p<0.001$)

Am J Kidney Dis 2008 vol. 51 (5) pp. 741-7

Cardiovascular Disease and Stones

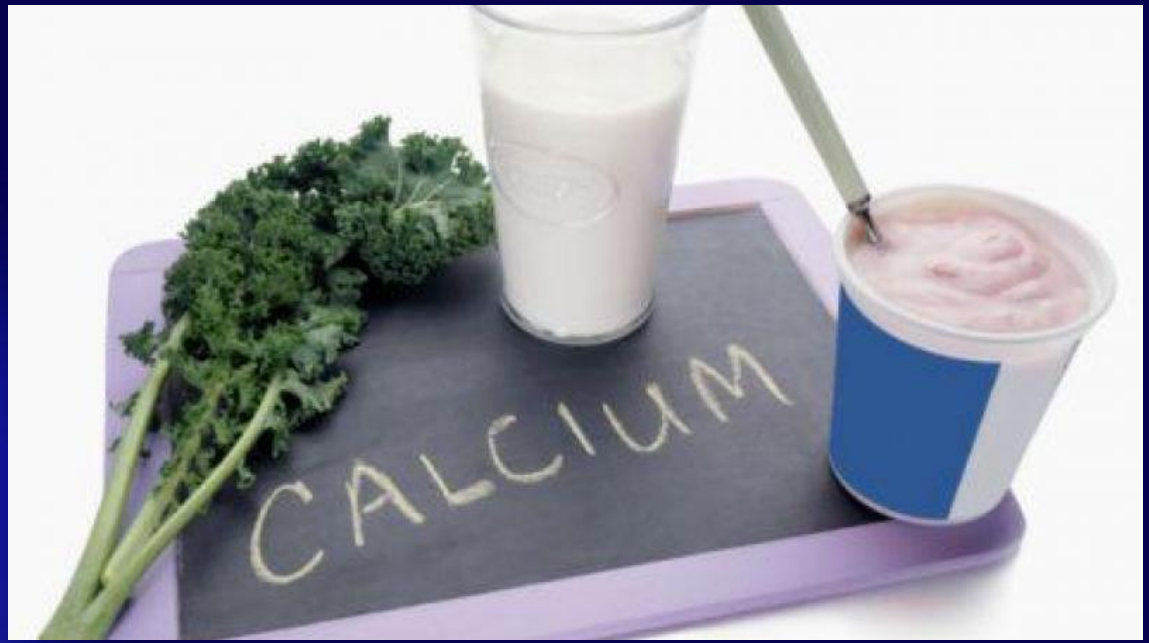
- Health Professional Follow-up Study: (40,000 men):
- If you have a kidney stone, you have increased risk of:
  - 15% increase in risk of heart disease
  - 16% inc'd risk of myocardial infarction
  - 27% inc'd risk of angina
  - 15% inc'd risk of coronary bypass

Eisner BH et al J Urol 2007; 177:449.

CUA: Dietary Recommendations

- FLUID! FLUID! FLUID!
  - Increase urine output to 2.5 L
- 1000 mg – 1200 mg Calcium daily
  - Do not restrict calcium intake!
- Lower sodium intake (to reduce hypercalciuria)
- ~~Limit oxalate-rich foods (spinach)~~
- Increase fruits and vegetables
- Limit animal protein - < 6-8 ounces / day

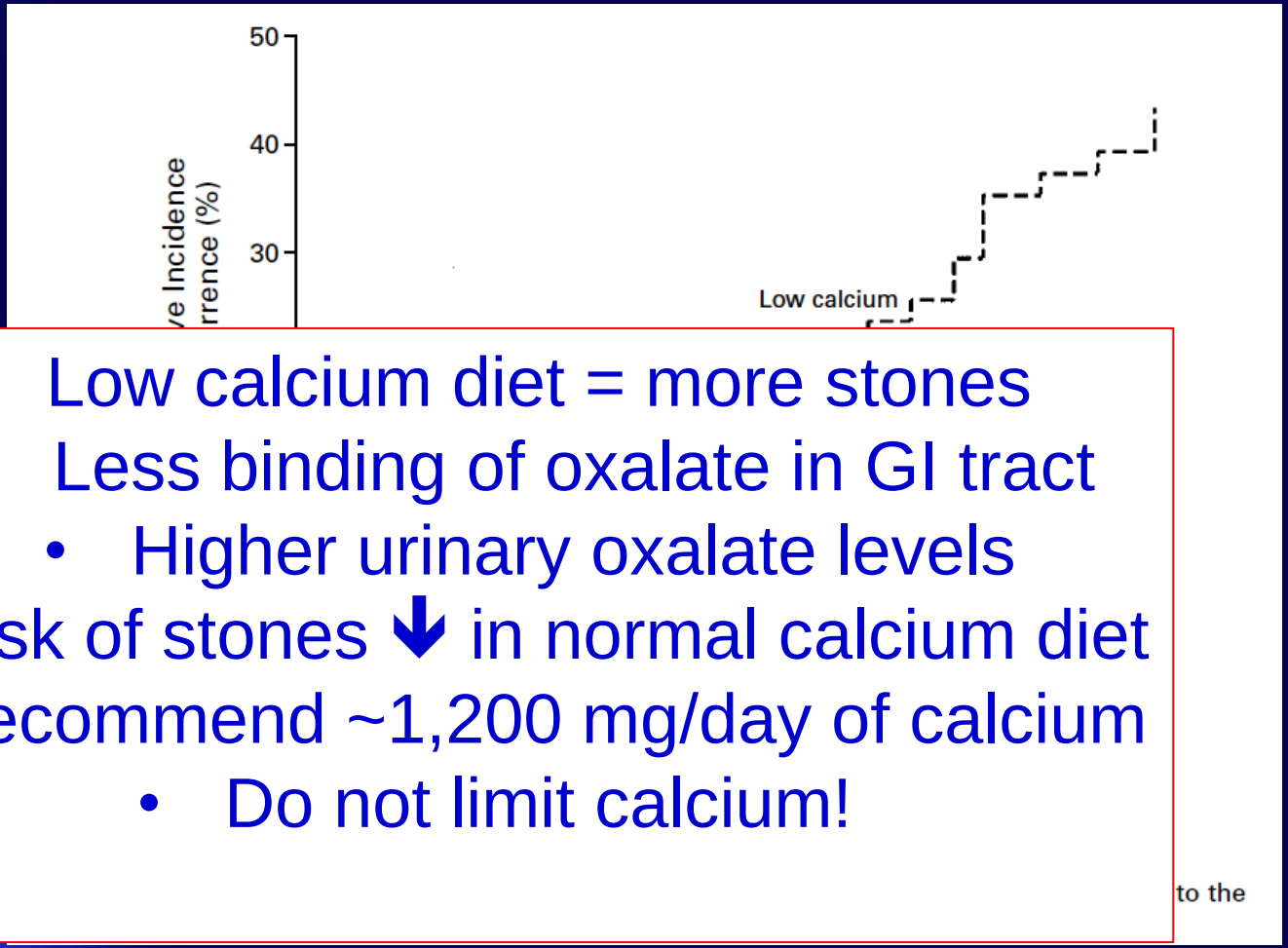
”Doc, didn’t eating calcium cause my kidney stone?”



Borghi Study

- **Normal calcium (1200mg) vs Low calcium (400 mg)**
  - 5 year prospective randomized trial (n=120)
  - Evaluated stone recurrence

N Engl J Med 2002 vol. 346 (2) pp. 77-84



- Low calcium diet = more stones
- Less binding of oxalate in GI tract
- Higher urinary oxalate levels
- Risk of stones ↓ in normal calcium diet
- Recommend ~1,200 mg/day of calcium
- Do not limit calcium!

N Engl J Med 2002 vol. 346 (2) pp. 77-84

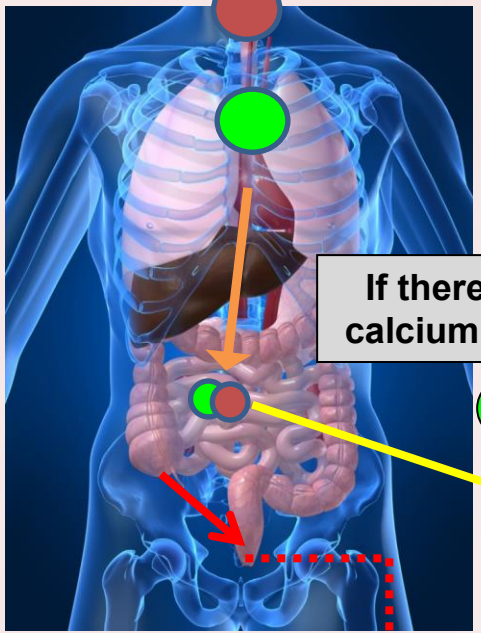
Slide courtesy of Kristina Penniston, PhD

Calcium binds oxalate in digestive tract

(if at the same place at same time)

You'll absorb less oxalate so… less oxalate in urine

(and you can still eat healthy, high-oxalate foods!)



If there's not calcium here…

oxalate oxalate oxalate oxalate

Oxalate pool

The oxalate NOT bound by calcium ends up here

Urine

oxalate oxalate oxalate oxalate

Feces

= The calcium and oxalate bound in your GI tract ends up here

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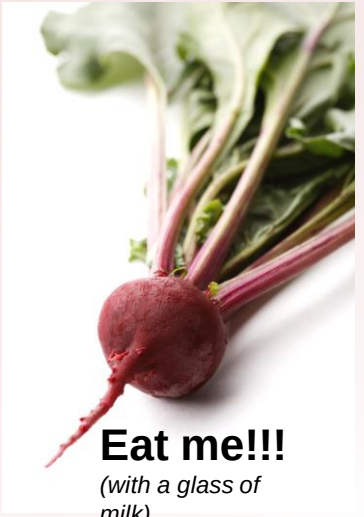
Slide courtesy of Kristina Penniston, PhD

High-Oxalate Foods



- **Don't limit oxalate if you don't have to**
  - **Most high-oxalate foods ARE HEALTHY!!!!!!**
- **Low calcium intake** is the cause of most people's high urine oxalate
- SO DO NOT AUTOMATICALLY STOP EATING THE HIGH-OXALATE FOODS THAT HAPPEN TO BE HEALTHY!!!!!!
- But… if you do eat LARGE PORTIONS of these foods on A REGULAR BASIS, consider smaller portions:
  - **Rhubarb**, **spinach** (both cooked and raw), **beets/ beet greens**, **chocolate**, **nuts/ nut butters**, **pot**

** REMEMBER: You don't have to stop eating these foods completely; just eat less IF high urine oxalate is a risk factor for you*

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DASH-Style Diet Associates with Reduced Risk for Kidney Stones

Eric N. Taylor,* Teresa T. Fung,† and Gary C. Curhan*‡

*Renal Division and Channing Laboratory, Department of Medicine, Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts; †Department of Nutrition, Simmons College, and Department of Nutrition, Harvard School of Public Health, Boston, Massachusetts; and ‡Department of Epidemiology, Harvard School of Public Health, Boston, Massachusetts

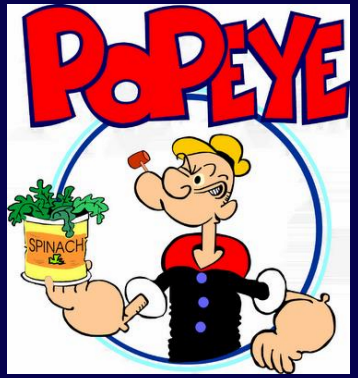
Dietary Approaches to Stop Hypertension

- Diet high in fruits and vegetables (↑Ox)
- Moderate in low-fat dairy products (↑Ca)
- Low animal protein

- Reduces stone formation
- Lowers blood pressure

Taylor et al, J Am Soc Nephrol 20(10):2253,2009

Recommended Daily Intake



- Calcium: 1,200 mg daily (WITH meals!)
- Vitamin D: 1,000 U daily
- Protein: 150-225 g/day (meat, fish, poultry)
- Sodium: 2400 mg/day (lower the better for stone formers)
- Oxalate: Spinach #1
  - Don’t limit oxalate (but probably wise to moderate spinach intake)
  - Eat WITH calcium!

Conclusions

- A kidney stone in an otherwise healthy patient may be a sign of other disease
  - Inc'd risk of heart disease, diabetes, obesity, hypertension
- Do not limit calcium intake
- Counsel patients for a *healthier diet* rather than a *restrictive diet*
  - DASH diet is good—healthy foods
  - Do not limit oxalate (only spinach)

Conclusions

- Follow up not well defined:
  - If stone free – follow q2-5 yrs w/ radiologic and metabolic w/u
  - If asymptomatic stone – image yearly until no progression (US/plain KUB okay)
  - Sooner re-evaluation if progression/recurrence

Thanks to Dr. Ben Chew video’s and guidance

Questions?