


TREATMENT AND SURVEILLANCE OF KIDNEY STONES

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OBJECTIVES

- Choose appropriate diagnostic imaging for kidney stone disease
- Understand the complexities of treatment timing
- Basic understanding of surgical options
- Principles of dissolution therapy
- Principles of medical expulsive therapy
- Know stone prevention resources
- Understand the purpose of surveillance and when to intervene surgically for non-obstructing stones



"Your kidney stone test came back. You didn't pass."


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CASE

A 47 YEAR OLD MALE PRESENTS FOR AN ACUTE VISIT WITH COMPLAINTS OF RIGHT FLANK PAIN. THE PAIN STARTED THE DAY PRIOR, IS 7/10 IN SEVERITY AND NON-RADIATING. HE HAS NOT TRIED PAIN MEDICATIONS. HE IS NAUSEATED, BUT NO VOMITING. HE DENIES DYSURIA, HEMATURIA, FREQUENCY, URGENCY, FEVER, OR CHILLS. HE HAS NEVER HAD PAIN LIKE THIS BEFORE.

PMH: Hypertension, Hyperlipidemia, obesity
PSH: none
SH: non smoker, construction worker
FH: No FH of stones.


PE:
afebrile, 160/90, 95
Normal physical exam except for R CVAT



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RENAL COLIC

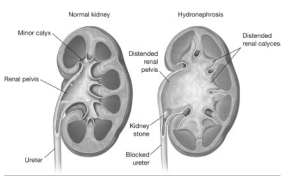
- ABRUPT ONSET OF UNILATERAL PAIN ORIGINATING IN THE FLANK (VIA LATERAL TO THE SPINE AND INFERIOR TO THE 12TH RIB)
- PAROXYSMAL
- NAUSEA & VOMITING COMMON DUE TO COMMON INNERVATION OF KIDNEYS, STOMACH, AND SMALL INTESTINE (CELIC PLEXUS)
- +/- HEMATURIA
- LOCATION OF PAIN MAY REFLECT THE SITE OF OBSTRUCTION
 - UPI, proximal ureter – flank pain
 - Mid ureter – lower abdominal pain
 - Distal ureter – irritative LUTS, groin pain
- PAIN CAUSED BY OBSTRUCTION, INFLAMMATION AND INFECTION
- NON-OBSTRUCTING STONES IN THE ABSENCE OF INFECTION TYPICALLY DO NOT CAUSE PAIN



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ACUTE FLANK PAIN/ RENAL COLIC – DIFFERENTIAL DIAGNOSIS

- HYDRONEPHROSIS
 - Stones
 - Stricture/ UPI obstruction
 - Malignancy
- PYELONEPHRITIS
- RENAL INFARCT
- RETROPERITONEAL HEMATOMA
- AORTIC ANEURYSMS
- CHOLECYSTITIS
- DIVERTICULITIS
- COSTOCHONDRITIS
- SPINAL DISC DISEASE
- PSOAS SPASM/ MUSCLE SPASM



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MECHANISM OF PAIN DURING ACUTE STONE EPISODE

- OBSTRUCTION OF URINARY FLOW → INCREASED WALL TENSION IN THE URINARY TRACT & RISING PRESSURE IN THE RENAL PELVIS → STIMULATES SYNTHESIS AND RELEASE OF PROSTAGLANDINS → VASODILATION → DIURESIS → INCREASES INTRARENAL PRESSURE FURTHER → MORE PAIN!
- PROSTAGLANDINS ALSO ACT DIRECTLY ON THE URETER TO CAUSES SPASM OF THE SMOOTH MUSCLE
- NSAIDS ACT DIRECTLY ON PROSTAGLANDIN RELEASE WHICH IS THOUGHT TO BE THE MAIN MECHANISM OF PAIN IN RENAL COLIC
- SYSTEMATIC REVIEW LOOKING AT PAIN MANAGEMENT FOR RENAL COLIC IN THE ACUTE SETTING (NSAIDS VS ACETAMINOPHEN VS OPIOIDS)
 - NSAIDs at least equivalent to opioids and acetaminophen for relief of pain at 30 minutes
 - Less vomiting with NSAIDs compared to opioids
 - Less rescue analgesia with NSAIDs compared to acetaminophen
 - NSAIDs should be the preferred analgesic option for patients presenting to the ED with renal colic

Holdgate et al. BMJ 2004.
Pathan et al. European Urology 2017.

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LABORATORY

UDIP – NEGATIVE EXCEPT FOR MICROSCOPIC HEMATURIA
 CBC NORMAL EXCEPT WBC 12
 BMP NORMAL WITH CREATININE 1.2

- Microscopic hematuria- suggestive of stone episode, but up to 18% can have stones with no hematuria
- Pyuria – concerning for UTI, but mild can be present from inflammation, nitrate positive is very concerning
- Leukocytosis is common (demargination, stress response from stone)
 - Must be taken into account with other clinical factors, >15K is most concerning for true infection
- Acute kidney injury
 - Dehydration
 - Bilateral obstruction
 - Unilateral obstruction in the setting of baseline renal insufficiency
 - Obstruction in a solitary kidney


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CASE

NON-TOXIC PATIENT WITH RENAL COLIC, MICROSCOPIC HEMATURIA, AND CONCERN FOR OBSTRUCTING KIDNEY STONE.

Imaging Options


- Renal Ultrasound
- KUB
- CT (noncontrast, low dose)



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IMAGING OPTIONS

- **RENAL US**
 - Useful as a screening test if suspicion is low
 - Useful in pregnant women and pediatric population
 - Does not visualize ureteral stones (but should see hydronephrosis)
 - Tends to overestimate the size of stones
 - Technician dependent
 - Cross sectional imaging is required prior to taking a patient to the OR for kidney stones




1. Clinicians should obtain a non-contrast CT scan on patients prior to performing PCNL. Strong Recommendation; Evidence Level Grade C
 2. Clinicians may obtain a non-contrast CT scan to help select the best candidate for SWL versus US. Conditional Recommendation; Evidence Level Grade C

- **KUB**
 - Useful to follow stone passage
 - Limited by obesity, phleboliths, radiolucent stones (uric acid), constipation, and size of stone (typically can only see 4 mm and above)

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IMAGING OPTIONS

- **NONCONTRAST CT (8-16 MSV)**
 - Imaging modality of choice
 - Meta-analysis of 4 prospective clinical trials showed superiority of CT over IVP
 - Improved positive and negative predictive bladder
 - 94-100% sensitivity, 92-100% specificity
 - Suggests an alternate diagnosis in 10% of cases
 - Reduces ED times by 2 hours compared to IVP
- **LOW DOSE CT (0.7MSV-2.8MSV)**
 - Meta-analysis of prior studies revealed sensitivity of 96.5% and specificity of 94.9%
 - Limited use in obese patients
 - Particularly useful in recurrent stone formers




Keywords: This, This, Address, and, Gang, Gang, Gang. "Optimal performance of low-dose CT for the detection of urolithiasis: a meta-analysis." American Journal of Roentgenology 195, no. 3 (2010): 588-95. doi:10.2200/100-100000-100000

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CASE


NON-TOXIC PATIENT WITH RENAL COLIC, MICROSCOPIC HEMATURIA, AND CT FINDINGS OF 4 MM DISTAL URETERAL STONE.



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TREATMENT TIMING

**NOW!
NEXT WEEK
NEXT MONTH**



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TREATMENT NOW: INDICATIONS TO SEND TO THE ED

- INFECTION
- ACUTE KIDNEY INJURY
- SEVERE PAIN NOT CONTROLLED BY ORAL ANALGESICS
- INABILITY TO TOLERATE PO DUE TO NAUSEA/ VOMITING
- COMPLICATING FACTORS
 - Immunocompromised / transplant patients/ Poorly controlled diabetes/ high risk for development of infection
 - Solitary kidney
 - Bilateral obstruction

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TREATMENT NEXT WEEK

- PAIN NOT WELL-CONTROLLED BY ORAL ANALGESICS
- PROLONGED UNILATERAL OBSTRUCTION/ MULTIPLE ED VISITS FOR THE SAME STONE
- LOW LIKELIHOOD OF SPONTANEOUS PASSAGE

TABLE 3: CHANCE OF PASSING URETERAL STONES

Stone size (mm)	Number of days to pass stone (mean)	% Likelihood of eventual need for intervention
2 or less	8	3
3	12	14
4-6	22	50
>6	-	99%



Two-thirds of ureteral stones that pass spontaneously pass within 4 weeks of the onset of symptoms.

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TREATMENT NEXT MONTH

- NON-OBSSTRUCTING STONES
- STONES 4 MM OR LESS THAT ARE EXPECTED TO PASS (RELIABLE PATIENTS)
 - Cannot assume stone passed – silent obstruction and renal loss

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OVERVIEW OF SURGICAL OPTIONS

- EXTRACORPOREAL SHOCKWAVE LITHOTRIPSY (ESWL)
- URETEROSCOPY (URS)
- PERCUTANEOUS NEPHROLITHOTOMY (PCNL)
- OPEN OR ROBOTIC REMOVAL OF STONE (RARELY PERFORMED)

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EXTRACORPOREAL SHOCKWAVE LITHOTRIPSY (ESWL)

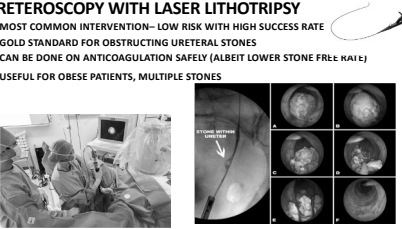
- USEFUL FOR SMALLER (< 1 CM) SINGLE, RADIOOPAQUE STONES IN THE KIDNEY IN THIN PATIENTS
- LOWER SUCCESS RATES/ CONTRAINDICATIONS
 - Obese
 - Hard stones
 - Multiple stones
 - Ureteral stones
 - Infected stones
 - CKD
 - Anticoagulation



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URETEROSCOPY WITH LASER LITHOTRIPSY

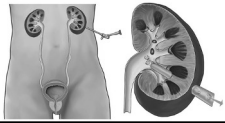
- MOST COMMON INTERVENTION— LOW RISK WITH HIGH SUCCESS RATE
- GOLD STANDARD FOR OBSTRUCTING URETERAL STONES
- CAN BE DONE ON ANTICOAGULATION SAFELY (ALBEIT LOWER STONE FREE RATE)
- USEFUL FOR OBESE PATIENTS, MULTIPLE STONES



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PERCUTANEOUS NEPHROLITHOTOMY (PCNL)

- GOLD STANDARD FOR STONE BURDEN > 2 CM, STAGHORN STONES
- HIGH SUCCESS RATE (95% STONE FREE RATE)
- RISKS
 - Prone positioning
 - Hemorrhage (5% risk transfusion)
 - Pulmonary complications - hydrothorax, pneumothorax, hemothorax (up to 10%)
 - Collecting system perforation/ urine leak
 - Requires nephrostomy tube and inpatient stay



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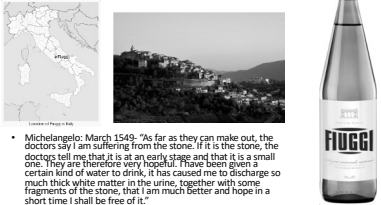
DISSOLUTION THERAPY & MEDICAL EXPULSIVE THERAPY

IS THERE SOMETHING I CAN TAKE TO DISSOLVE THIS STONE?

IS THERE SOMETHING I CAN TAKE TO HELP PASS THIS STONE?

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DISSOLUTION THERAPY - IS THERE SOMETHING I CAN TAKE TO DISSOLVE THIS STONE?



- Michelangelo: March 1549: "As far as they can make out, the doctors say I am suffering from the stone. If it is the stone, the doctors tell me that it is at an early stage and that it is a small one. They are therefore very hopeful. I have been given a certain kind of water to drink. It has caused me to discharge so much thick white matter in the urine, together with some fragments of the stone, that I am much better and hope in a short time I shall be free of it."

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

Robert Pickard, Kathryn Stan, Georina Macleod, Thomas Lam, Ruth Thomas, James Ben, Gajya Mithras, Alison McDonald, Kenneth Anson, James Dow, Neil Burgess, Terry Clark, Mary Kilares, Katie Gillet, Kirsty Shearer, Charles Boachie, Sarah Cameron, John Nonic, Samuel McClellan

- RCT AT 24 UK HOSPITALS
- ADULTS WITH STONES <10MM (75% HAD STONES <5MM)
- Excluded those with sepsis, renal dysfunction
- TAMSULOSIN VS NIFEDIPINE VS PLACEBO 3 28 DAYS
- 1167 PARTICIPANTS (97% IN PRIMARY OUTCOME)
- NO INTERVENTION AT 4 WEEKS END POINT: TAMSULOSIN GROUP (81%), NIFEDIPINE (80%), PLACEBO (80%)
- LIMITATION: LIMITED SUBGROUP ANALYSES

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ARTICLE IN PRESS

Review Article

What Is the Role of α -Blockers for Medical Expulsive Therapy? Results From a Meta-analysis of 60 Randomized Trials and Over 9500 Patients

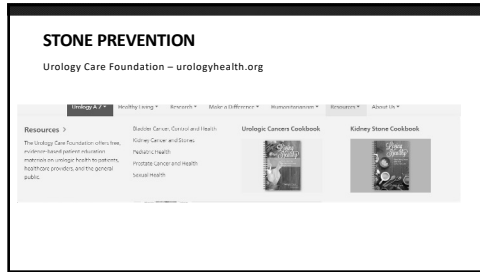
Omar M. Aboumarzouk, Patrick Jones, Tarik Amer, Dimitris Kotsiris, Esteban Emiliani, Bhaskar Somani, Panagiotis Kallidonis, Thomas Tally, Gohkan Atis, Francesco Greco, Stephan Hruby, Mario Alvarez, Khalid Al-Rumailhi, Ahmad Shamsodini, Abdulla Al-Ansari, and Ahmed Shokier

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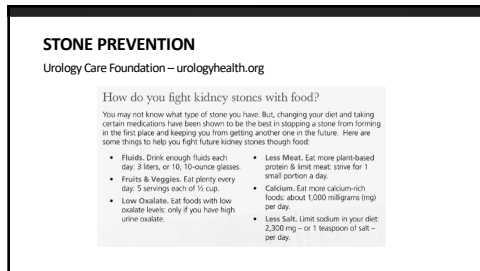
MEDICAL EXPULSIVE THERAPY

- 60 RCTS INCLUDED, 1994 – 2017
- 9,517 PATIENTS
- ALL STUDIES COMPARED AN ALPHA BLOCKER WITH A CONTROL GROUP (MAJORITY TAMSULOSIN)
- MET EFFICACY
 - Favored alpha blockers (80% vs. 64.1%, $p < 0.0001$)
- TIME TO EXPULSION
 - Favored alpha blockers
- SUBGROUP ANALYSIS LOOKING AT SIZE
 - Stones < 5 mm: No difference (84.7% vs. 82.4%, $p = 0.13$)
 - Stones > 5 mm: Favored alpha blockers (78.5% vs. 62.6%, $p < 0.00001$)
- MET SAFETY
 - More adverse events in the alpha blocker group (6.8% vs. 3.5%, $p < 0.00001$)

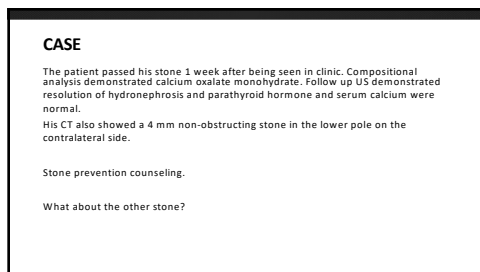
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NON-OBSTRUCTING STONES

- **ACTIVE SURVEILLANCE OR INTERVENTION?**
 - Current guidelines are equivocal and studies are mixed
- **WHAT IS THE NATURAL HISTORY OF THESE STONES?**
 - Kang et al. Korea 2013.
 - 347 patients with asymptomatic renal stones (over half in lower pole; mean stone size 4.4 mm, max 10.7 mm)
 - Mean follow-up 31 months
 - Spontaneous passage in 29%
 - 50% developed symptoms (median 19 months)
 - 25% underwent intervention
 - Yuruk et al. Turkey 2010
 - LPS < 2 cm
 - 19% of patients required intervention at median 22 months (stone growth, development of symptoms, or UTIs)

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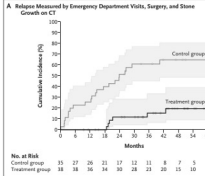
NON-OBSTRUCTING STONES

- **SORENSEN ET AL. 2022 NEJM**
 - Patients scheduled for surgery for a primary symptomatic stone with secondary asymptomatic stones (≤ 6 mm)
 - 75 patients randomized to removal of just the primary stone or both stones
 - Primary outcome – “relapse”
 - ER visit due to stones on the same side as the asymptomatic side
 - Secondary surgery needed on asymptomatic side
 - Growth of the stone on CT

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NON-OBSTRUCTING STONES

- **SORENSEN ET AL. 2022 NEJM**
 - 63% relapse in control group
 - 16% relapse in treatment group
 - Time to relapse 697 days longer in treatment group
 - Cumulative incidence of new stones was the same in both groups (37%)



A. Relapse Measured by Emergency Department Visit, Surgery, and Stone Growth on CT

Months	Control group (%)	Treatment group (%)
0	0	0
4	10	0
8	20	0
12	30	0
16	40	0
20	50	0
24	60	0
28	65	0
32	68	0
36	70	0

No. at Risk

Months	Control group	Treatment group
0	35	35
4	33	33
8	31	31
12	29	29
16	27	27
20	25	25
24	23	23
28	21	21
32	19	19
36	17	17

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NON-OBSTRUCTING STONES

- **ACTIVE SURVEILLANCE OR INTERVENTION?**
 - Need more studies
 - Shared decision making
 - If less than 6 mm, ~20% chance of spontaneous passage in 5 years
 - ~50% chance of needing intervention in 2-5 years
 - NEJM article shows us that removing them prevents ER visits and subsequent surgery
 - I tell patients – take care of it on your own terms or let the stone decide – may never need intervention, but could also need it urgently on the day you are leaving for vacation
 - Lean towards intervention in young, healthy patients, pilots, or rural travelers
 - Follow for stone growth or movement – can use ultrasound for direct comparisons, but CT is always most accurate


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FAMOUS STONES

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WILLIAM SHATNER

- Sold a passed kidney stone in 2006 for \$75,000
- The money was used to build a home for a family which had lost theirs in Hurricane Katrina



10. I consent to the disposal by Hospital authorities of any tissue, body parts or implants, which may be removed.

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GENE SIMMONS

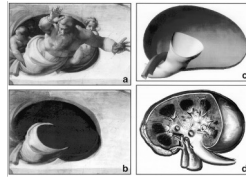
- Simmons also sold a kidney stone on E-bay for charity.
- He only got \$15,000.



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MICHELANGELO

- Long history of gouty arthritis and recurrent nephrolithiasis
- Died with symptoms of fluid overload and stones – obstructive nephropathy
- Demonstrated an interest in the kidney through his art (renal outline can be found in many works)



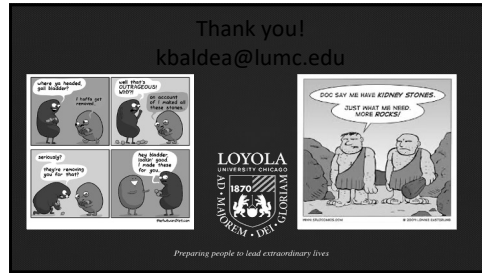
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BENJAMIN FRANKLIN

- Suffered from a large bladder stone that left him bedridden and confined to his house for the last year of his life
- Invented flexible urinary catheter (metal prior to this) to help his older brother who had stones and urinary retention



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