JOHN MUIR HEALTH

Management of Urinary Stones

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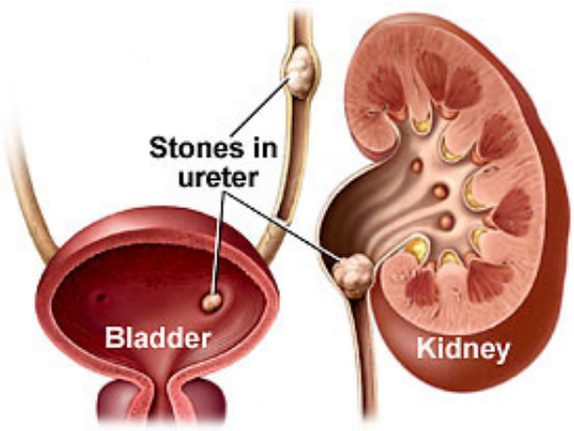
Introduction

Urinary stone prevalence is estimated at 3% of U.S. men and women and affects up to 12% of the population during their lifetime. Recurrence rates for urinary stones are about 50% at 10 years. White males have the highest incidence in the U.S, with a higher incidence found in areas of the country where hot weather and dehydration are more likely to occur. The hotter summer months often result in a greater number of people presenting with urinary stones.

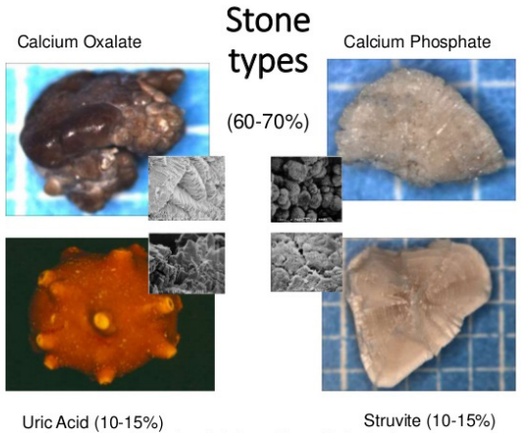
With the development of modern techniques for treatment, mortality from urinary stones is rare. However, there is still a significant rate of renal deterioration (28%) with certain stone types. The pain associated with urinary stone obstruction has often been described as the most severe pain ever experienced by patients, including childbirth. Urinary stones account for more than two million health care professional (HCP) visits and over 600,000 emergency room (ER) visits per year.



Pathophysiology

There are five primary types of urinary stones. Calcium oxalate stones are the most common, accounting for about 60% of all stones. These stones typically form from an initial accumulation of calcium phosphate, and eventually turning to calcium oxalate when directly

exposed to urine. About 10% of all stones are calcium phosphate stones. Calcium phosphate stones result primarily from an underlying metabolic disorder such as renal tubular acidosis. Uric acid stones and struvite stones are less common. Uric acid stones represent about 10%-15% of all stones, with the most common risk factor being persistently acidic urine. Struvite stones, accounting for about 10%-15% of all stones, are caused by urinary infections. Less than 1% of all stones are cystine stones, which are produced in patients with a homozygous recessive gene for cystine transport resulting in excessive urinary cystine levels.



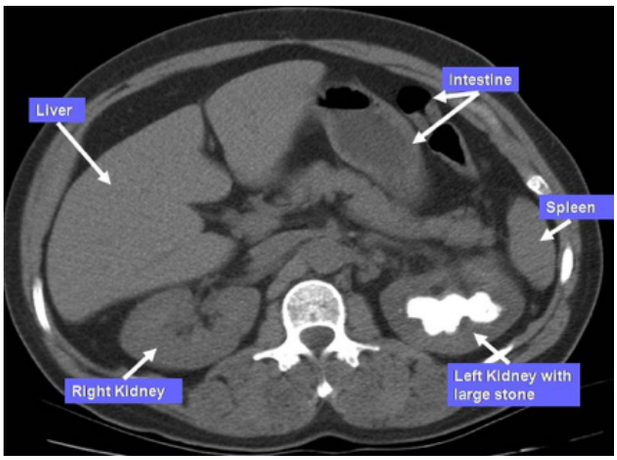
Clinical presentation

Most patients with a urinary stone present with acute flank pain radiating to the groin or scrotum. Pain is often accompanied by nausea and vomiting. As the stone descends in the ureter, pain may localize in the abdominal area overlying the stone. Lower quadrant pain along with urinary urgency, frequency and dysuria often follow as the stone approaches the junction where the ureter enters the bladder. Patients presenting with urinary stones are often writhing and constantly moving to find a comfortable position, while some patients do not want to move at all. Blood in the urine (hematuria) is present in approximately 85% of patients. A family history of stones is linked to 55% of patients with recurrent urinary stones.

Acute flank pain in the absence of hematuria, however, does not preclude the presence of urinary stones as there may be complete obstruction. Other acute abdominal conditions may also cause nausea and vomiting so that a rapid and accurate diagnosis is very important.

Diagnostic Evaluation

The current standard for confirming urinary stones is a non-contrast helical computerized tomography (CT) scan of the abdomen and pelvis. See example CT scan that follows on next page of left kidney with large stone. Where CT is not available, a regular x-ray of the kidney, ureters and bladder (KUB) is quite useful and is also recommended as an adjunct to any CT scan that shows positive for urinary stones. The KUB also provides a good way to determine stone shape and helps to track stone progress.

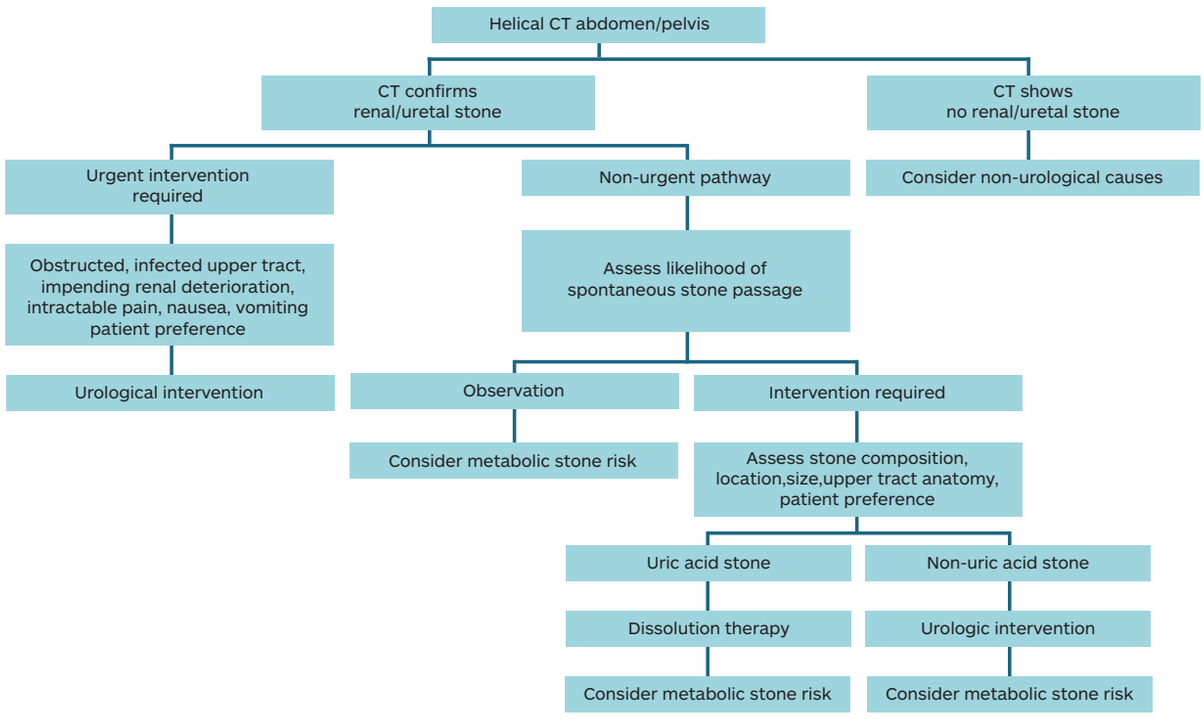


Ultrasound is less sensitive than a CT scan for urinary stones, especially for those present in the ureter. However, ultrasound is the recommended first imaging test in pregnant women. Ultrasound may also be useful to identify non-calcified stones the KUB might miss.

Management

The diagram below outlines a clinical algorithm from the American Urological Association for managing patients with urinary stones. Separate pathways are recommended for urgent versus non-urgent intervention.

Management of acute renal colic



Once a CT scan or other imaging method has confirmed a urinary stone, the first important clinical decision is whether or not urgent intervention is required.

Urgent management

The table below outlines the indications for urgent intervention.

Indications for urgent Intervention with urinary stones*
Obstructed upper tract with infection
Impending renal deterioration
Pain refractive to analgesics
Intractable nausea/vomiting
Patient preference

* American Urological Association

Fully obstructed cases or infected cases should be surgically decompressed either by percutaneous nephrostomy or ureteral stent placement. Unstable patients or septic patients should have their blocked collecting system immediately drained, and treatment of the obstructing stone delayed until any infection (indicated by fever and/or elevated WBC) is under control.

Patients with a solitary or transplanted kidney and moderate or severe stone obstruction are cases where impending renal deterioration is quite possible. These cases require rapid resolution of the blockage with drainage or surgery.

Narcotics and non-steroidal anti-inflammatory drugs (NSAIDS) are most commonly used for pain relief in patients with stone obstruction. NSAIDs may be a problem for patients with decreased renal blood flow due to urinary stone obstruction, particularly in patients with pre-existing renal impairment. Because NSAIDs cause platelet inhibition, they may also pose a concern for patients requiring surgery because of the increased bleeding risk. Other agents, such as intravenous acetaminophen may also be used to alleviate pain. Intractable pain is effectively controlled by decompressing the obstruction with percutaneous nephrostomy or ureteral stenting.

Patient preference is also an indication for urgent intervention, as patients who have undergone previous stone removal may wish to avoid future invasive procedures.

If urgent intervention is unnecessary, the next important clinical decision is whether to allow patients to pass their stone spontaneously, or to provide options for medical or surgical intervention.

Non-urgent (Expectant) management

Stone size and location are the key factors in predicting whether a urinary stone will pass spontaneously. The ureter is the area most prone to stone obstruction due to it being the smallest part of the urinary tract. Stones smaller than 5 mm in diameter are likely to pass spontaneously, but the likelihood of passage decreases as stone size increases (see table below).

Options for stone intervention*

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

* American Urological Association

Overall, two thirds of ureteral stones pass spontaneously within 4 weeks of the onset of symptoms. Certain medications known as medical expulsion therapy (MET) that relax ureteral muscle and reduce ureteral spasm may be used to facilitate passage. These include calcium channel blockers, alpha blockers and corticosteroids. MET is most effective for small, lower ureteral stones, and has been shown to increase the likelihood of passage by 30%.

An observation period of four weeks is customary for most patients. A stone that has not passed or moved in one to two months is unlikely to do so with additional observation. During the observation period, the patient should be followed for stone passage, stone growth and new infections. Symptoms such as unbearable pain, infection and impending renal deterioration may warrant intervention during the observation period. If the patient does pass the stone, it is recommended they retrieve all or part of it for analysis so the information may be used in the event of recurrent stones.

Medical and surgical management

When intervention is warranted, treatment is determined by composition, size and location of the stone, upper urinary tract anatomy, and patient preference. Options for stone intervention appear below.

Options for stone intervention*
Oral stone dissolution
Extracorporeal shock wave lithotripsy (SWL)
Ureteroscopy
Percutaneous nephrolithotomy (PCNL)
Open or laparoscopic lithotomy

* American Urological Association

Uric acid stones may be completely dissolved with oral medications such as potassium citrate or sodium bicarbonate. Maintaining a ph level of at least 6.5 usually results in dissolution in two to six weeks.

Urinary stones less than 2-3 cm in diameter and located in the upper urinary tract are best treated with **Extracorporeal Shock Wave Lithotripsy (ESWL)**. ESWL focuses shock waves on the stone from outside the body to fragment the stone where then it is easily passed. Efficacy rates using ESWL vary depending on the number, size, location and density of the stones, the specific ESWL device being used, and the total number and rate of shocks given. Additional benefits of ESWL include no hospitalization required, short treatment times, and that patients are back to work within a few days. This may explain why ESWL is the patient-preferred treatment method.

Patients with stones in the lower urinary tract may have better success if treated with **ureteroscopy**. Ureteroscopy involves passing a semi rigid or flexible digital ureteroscope from the bladder, up through the ureter and into the renal collecting area. Using sophisticated laser lithotripsy devices and imaging, most stones can be located and removed, or fragmented into tiny pieces (< 1 mm) that can pass painlessly.

Patients with stones that are larger than 2-3 cm are best treated by **percutaneous nephrolithotomy (PCNL)**, with or without adjunctive ESWL. PCNL involves placement of small catheter through the flank into the renal collecting area. The catheter is then dilated to allow passage of either a rigid or flexible nephroscope into the collecting area. Various devices are then passed through the nephroscope to grab and/or fragment the stone for removal. PCNL is more invasive than ESWL and has a higher incidence of bleeding, transfusions, prolonged analgesic use and other adverse events.

The charts below compare the three treatment methods.

Comparing Ureteroscopy, Shockwave Lithotripsy, & Percutaneous Nephrolithotripsy

	 Ureteroscopy	 Shockwave Lithotripsy	 Percutaneous Nephrolithotrispy
DESCRIPTION	Small flexible camera used to enter ureter and kidney. Laser fiber used to fragment stone. Stone fragments extracted or allowed to pass on their own.	Uses focused sound waves from outside the body to fragment a stone. X-rays used to target stone. Patient passes stone fragments.	Small puncture made into kidney directly through skin of back. Allows larger instruments to be used which can break up and suction out stone fragments.
BEST FOR	-Small to medium stones (<1 cm) -Multiple stones -Stones in ureter	-Stones visible on plain x-ray -Small to medium stones (<1cm)	-"Staghorn stones" -Large stones (>2cm) -Some medium stones (1-2cm)
BENEFITS	Highest success rate for small to medium stones	Least discomfort	Best option for large stones
TYPICAL OPERATIVE TIME	1 hour	1/2 hour	1-2 hours
USUAL HOSPITAL STAY	Usually none	None	1-2 days
AVERAGE # DAYS BEFORE BACK TO WORK	8.5	3.3	* (we estimate 1 week)
AVERAGE # DAYS BEFORE 100% RECOVERED	15.6	8.1	* (we estimate 2 weeks)
% OF PATIENTS WHO WOULD CHOOSE THIS AGAIN	63%	90%	* (no data available)
CONSIDERATIONS	May require stent removal procedure in clinic if stent Placed. Stent discomfort reason for slower recovery.	Because of lower success rate, more likely to require repeat procedures.	Hospital stay required. Temporary nephrostomy tube or ureteral stent usually placed after surgery.

Note that not all stones require surgical treatment. Stones in the kidney that are not causing symptoms and stones small enough to pass can often be observed.

Your urologist may take several other variables into consideration when deciding on which procedure to recommend. These can include: stone size, location of a stone, hardness of a stone, your body size and shape, your other medical conditions, your urologists' experience and training, and availability of surgical equipment.

www.KidneyStoners.org *Some data adapted from a study by Pearle and colleagues. Journal of Urology 2005.*

Medical management of urinary stones at John Muir Health

When considering where patients with urinary stones should be treated, it's important to choose a health care facility that has experience in all the various treatment approaches described in this paper. That's because there is no single approach that is effective for all types of urinary stones. John Muir Health, and its relationship with Pacific Urology and other urology practices in the East Bay, provides a comprehensive approach to managing urinary stones, including offering the latest diagnostic tools and minimally invasive interventions. John Muir Health is also one of only a few Bay Area facilities with a fixed lithotripsy suite on site, enabling physicians to schedule ESWL appointments for their patients without delay. Best outcomes in the management of urinary stones is also based on following established guidelines. Following established guidelines for managing urinary stones is also important for best outcomes. John Muir Health has adopted guidelines from the American Urological Association that were recently developed in 2012 and updated in 2014.

About the Author

Dr. Zheng is a practicing Urologist with offices in Walnut Creek and Concord, and is affiliated with John Muir Health Medical Center at the Concord and Walnut Creek campuses. He completed medical school and his Internship and Residency at McGill University Faculty of Medicine, and received his Fellowship training at the University of Western Ontario. He is certified by the American Board of Urology.