

Kidney Stone (Ureterolithiasis)

A tiny rock slides down the drain from kidney to bladder and gets wedged in the pipe, so the kidney backs up and the body screams.

THE STORY IN ONE SENTENCE

A tiny rock slides down the drain from kidney to bladder and gets wedged in the pipe, so the kidney backs up and the body screams.

“A pebble in the drainpipe. Everything upstream is under pressure until it moves.”

Normal anatomy — the body's job

The kidneys sit in your back on each side, below your ribs. They filter your blood and make pee. Pee drains through a narrow pipe called the ureter — about the width of a pencil lead — from each kidney down into the bladder. The ureter has three natural narrow spots where a stone is most likely to get stuck.

BODY'S JOB

Move pee from kidney to bladder without holding pressure back on the kidney.

1. Kidney (renal pelvis) — The funnel that catches all the pee the kidney makes.
2. UPJ (ureteropelvic junction) — First narrow spot, where the ureter connects to the kidney.
3. Ureter (pelvic brim) — Second narrow spot, where the ureter crosses over the iliac blood vessels as it enters the pelvis.
4. UVJ (ureterovesical junction) — Third narrow spot at the bladder — the tightest of all, where the ureter tunnels through the bladder wall.
5. Bladder — Where pee is stored until you are ready to go.

What breaks

Minerals in the pee — mostly calcium oxalate, sometimes uric acid or struvite — clump together and harden into a stone. If that stone moves out of the kidney and gets stuck in the ureter, pee cannot flow past it. The pressure backs up into the kidney above.

CLINICAL TERM

Obstructing ureteral calculus causing hydroureter and hydronephrosis.

How the body compensates

The ureter above the stone squeezes harder to try to push the stone along. That squeezing is what causes the wave-like pain called renal colic. The kidney above the block swells with backed-up pee, a condition called hydronephrosis.

1. The ureter grabs the stone and spasms in waves — this is the extreme, cramping pain called renal colic.
2. Pressure backs up through the ureter and swells the kidney's collecting funnel (the renal pelvis) — this is hydronephrosis.
3. The high pressure squeezes the kidney's tiny filters (the nephrons) — kidney function starts to drop if the block lasts.
4. The stone scrapes the inside of the ureter, so small tears show up as blood in the pee (you may see red or brown pee, or only a microscope picks it up).
5. If bacteria are in the pee behind the block, you have an infected obstructed system — this can turn into sepsis fast and is a medical emergency.

Domino effect

1. A stone forms in the kidney over weeks to months. — When pee gets too concentrated, minerals like calcium and oxalate stick together and crystalize into a hard pebble.
2. The stone slips out of the kidney and enters the ureter. — Gravity and the flow of pee push the stone down the drain.
3. The stone gets stuck at one of the three natural narrow spots in the ureter. — The ureter is only about 2 to 3 millimeters wide at its narrowest — barely wider than a pencil lead — so even a small stone can wedge tight.
4. The ureter cramps hard trying to squeeze the stone along. — Smooth muscle in the ureter wall reacts to the blockage by spasming in waves, which is what causes the intense, cramping pain of renal colic.
5. Pressure backs up into the kidney, swelling the renal pelvis (hydronephrosis). — Pee keeps being made but has nowhere to go, so it pools and stretches the kidney.
6. Pain, blood in the pee, and nausea hit hard and fast. — The cramping ureter and the stretched kidney capsule both send pain signals, and the pain is so severe it triggers a reflex that makes you throw up.

7. If untreated, the kidney can get injured, infected pee can pool above the block, or sepsis can set in. — Backpressure damages the kidney's filters over time, and stagnant infected pee is a setup for bacteria to spill into the bloodstream.

Symptoms · what the patient feels, and why

- Sudden, severe pain in the side (flank) that shoots down to the groin: The stone is stuck in the ureter (the thin tube that carries pee from the kidney to the bladder), causing it to squeeze hard in waves—like trying to push a pebble through a straw. At the same time, the kidney's outer shell (the capsule) stretches from backed-up urine. These squeezing waves (called colic) come and go every 20 to 60 minutes.
- Restlessness—constantly shifting position, can't sit still or get comfortable: Belly pain from organs inside a bag (the peritoneum)—like from the appendix—makes you lie still because movement hurts more. But kidney-stone pain comes from the ureter, which squeezes in waves, so your body instinctively moves around trying to find relief.
- Blood in the urine (pink, red, or brown pee, or only visible under a microscope): The sharp edges of the stone scrape the inside lining of the ureter as it moves, tearing tiny blood vessels and letting red blood cells leak into the urine.
- Nausea and vomiting: The nerves that sense pain from the ureter share wiring in the spinal cord with nerves that trigger the brain's vomiting center (the area postrema in the brainstem). When the ureter sends a pain signal, the vomiting center gets switched on as well.
- Needing to pee often and urgently, especially when the stone is almost in the bladder: When the stone reaches the ureterovesical junction (UVJ—the spot where the ureter empties into the bladder), it rubs and irritates the bladder wall, making the bladder feel full and triggering the urge to pee even when little urine is inside.
- Fever and shaking chills: If bacteria are trapped behind the stone, they multiply in the backed-up urine and release toxins into the bloodstream (sepsis). The hypothalamus (the brain's thermostat) raises body temperature to fight infection, causing fever and chills.
- No urine coming out, and rising creatinine (a blood test showing kidney function is dropping): Either both ureters are blocked by stones, or the person has only one working kidney and that ureter is blocked. Without a way out, urine backs up, pressure rises, and the kidneys stop filtering waste, so creatinine (a waste product made by muscles) builds up in the blood.

Focused exam

- Costovertebral angle (CVA) tenderness: Pain when you tap over the kidney (the back just below the ribs) tells you the kidney or the tube draining it (the ureter) is inflamed or blocked on that side.
- Restless, shifting positions constantly, cannot lie still: This restless behavior is a signature of kidney stone pain (renal colic). The waves of pain come from the ureter squeezing against the stone like a clogged pipe. In contrast, people with a belly infection (peritonitis) lie very still because any movement hurts more.
- Normal bowel sounds: The gut is still working normally. This helps rule out a bowel blockage or other abdominal emergency and points toward a urinary problem instead.
- Fever plus fast heart rate (tachycardia) plus low blood pressure (hypotension): A blocked, infected kidney can pour bacteria into the blood, triggering sepsis (a body-wide infection response) that can become life-threatening shock. This trio of signs means the person needs emergency drainage (a stent or a tube) and IV antibiotics right away.

Diagnostics · every test answers a question

- Non-contrast CT scan of the abdomen and pelvis → Where is the stone, how big is it, and is the kidney swollen (obstructed)?
- Bedside renal ultrasound → Is the kidney swollen (hydronephrosis) from a backup of urine?
- Urinalysis (urine dipstick and microscopy) → Is there blood, infection, or crystals in the urine?
- Basic metabolic panel (BMP) → Are the kidneys working normally? Are electrolytes balanced?
- Complete blood count (CBC) → Are there signs of infection or sepsis?
- Stone strain (patient collects any passed stone in a filter) → What type of stone is it, so we can prevent the next one?

Treatment logic

- Intravenous (IV) fluids plus IV ketorolac (an NSAID pain medicine), with opioid rescue if needed → Fluids rehydrate the person and help flush the urinary system. Ketorolac lowers prostaglandins (chemicals that make the ureter spasm and swell), which eases the waves of pain. Opioids (like morphine) can be added if ketorolac alone is not enough.
- IV ondansetron (an anti-nausea medicine) → Blocks serotonin (a brain messenger that triggers vomiting) in the gut and brain, stopping nausea and vomiting caused by ureteral irritation and pain signals.

- Tamsulosin (an alpha-blocker) for medical expulsive therapy → Relaxes the smooth muscle in the ureter wall, widening the tube so stones (especially distal stones between 5 and 10 mm) can pass more easily and faster. Typically taken once daily for up to 4 weeks.
- Ureteral stent or percutaneous nephrostomy tube (a drainage tube through the skin into the kidney) → Restores drainage of urine past or around the stone, relieving pressure on the kidney. This is life-saving in an infected, obstructed kidney (obstructive pyelonephritis) because it stops bacteria from backing up into the bloodstream.
- Extracorporeal shock wave lithotripsy (ESWL) or ureteroscopy with laser lithotripsy → ESWL uses sound waves from outside the body to break the stone into small pieces that can pass. Ureteroscopy threads a tiny camera and laser up through the urethra and bladder to the ureter, then breaks up or plucks out the stone. Both remove the stone and clear the blockage.

Medications

Ketorolac (Toradol) · NSAID — cyclooxygenase inhibitor

Blocks the body chemicals called prostaglandins that make the ureter (the tube from kidney to bladder) squeeze too hard. When the ureter relaxes, the kidney capsule (the thin wrapping around the kidney) stretches less, and the pain drops fast.

1. Ketorolac blocks two enzymes — COX-1 and COX-2 — that make prostaglandins (chemicals that trigger pain, swelling, and muscle squeezing).
2. With less prostaglandin, the ureter stops spasming so hard.
3. The kidney capsule stretches less because pressure inside the kidney drops.
4. Pain drops within 15 to 30 minutes after the shot or pill.

SAFETY WATCH

Do not use if kidney function is already weak — ketorolac can worsen kidney injury. · Watch for stomach bleeding, especially in older adults or if used for more than 5 days. · Do not use after 20 weeks of pregnancy — can harm the baby's heart and kidneys. · Can raise blood pressure slightly; use with caution if blood pressure is already high.

Tamsulosin (Flomax) — medical expulsive therapy · Alpha-1A blocker (selective)

Relaxes the smooth muscle wrapped around the lower ureter and the spot where the ureter meets the bladder (called the ureterovesical junction or UVJ). That spot acts like a tight ring —

stones often get stuck there. Relaxing the ring makes it easier for the stone to slide through and drop into the bladder.

1. Tamsulosin blocks alpha-1A receptors on the smooth muscle cells of the ureter and bladder neck.
2. When those receptors are blocked, the muscle relaxes and stops squeezing.
3. The narrowing at the UVJ opens up.
4. The stone has a wider, smoother path and is more likely to pass into the bladder, then out through the urethra when you urinate.

SAFETY WATCH

Dizziness or lightheadedness on the first dose — take at bedtime and stand up slowly. · Retrograde ejaculation (semen goes backward into the bladder instead of out) — harmless but can be surprising. · Rare: sudden drop in blood pressure when standing, especially if also taking blood-pressure medicine.

Ibuprofen or Naproxen · NSAID — cyclooxygenase inhibitor

Blocks prostaglandins (body chemicals that cause pain, swelling, and muscle spasm) in the ureter and kidney capsule. Less prostaglandin means less spasm and less stretch, so pain drops.

1. Ibuprofen or naproxen blocks COX-1 and COX-2 enzymes that make prostaglandins.
2. Less prostaglandin means the ureter relaxes and stops spasming.
3. The kidney capsule stretches less because pressure inside the kidney drops.
4. Pain drops within 30 to 60 minutes.

SAFETY WATCH

Can worsen kidney function — use carefully if kidney disease is already present, or avoid. · Can cause stomach irritation, ulcers, or bleeding — take with food. · Can raise blood pressure slightly — monitor if blood pressure is already high. · Do not use after 20 weeks of pregnancy.

Opioids (morphine, hydromorphone, oxycodone) · Opioid analgesic — mu-receptor agonist

Binds to opioid receptors in the brain and spinal cord (especially mu receptors) and blocks the pain signal before it reaches your awareness. Does not stop the kidney or ureter from hurting — it just turns down how much your brain notices and cares about the pain.

1. Opioid binds to mu receptors in the brain and spinal cord.

2. Turns on inhibitory pathways that send 'quiet down' signals back down the spinal cord.
3. Pain signals from the kidney and ureter are blocked before they reach the brain's awareness centers.
4. You feel less pain within 15 to 30 minutes (IV) or 30 to 60 minutes (oral).

SAFETY WATCH

Nausea and vomiting — very common with kidney-stone pain plus opioids. · Constipation — worsens over days if used repeatedly. · Drowsiness and confusion — do not drive or operate machinery. · Respiratory depression (slowed breathing) if dose is too high or combined with sedatives or alcohol. · Risk of dependence with repeated use — reserve for severe pain when NSAIDs are not enough or not safe. · Can worsen nausea from the stone itself — often combined with an anti-nausea medicine like ondansetron.

Ondansetron (Zofran) · 5-HT₃ receptor antagonist (serotonin blocker)

Blocks serotonin receptors (5-HT₃) in the vomiting center of the brainstem and in the gut. Serotonin is released when the gut or kidney is irritated; blocking its signal stops the nausea and vomiting that often come with severe kidney-stone pain.

1. Pain and irritation from the kidney stone trigger serotonin release in the gut and brainstem.
2. Ondansetron blocks 5-HT₃ receptors so serotonin cannot deliver its 'vomit now' message.
3. The vomiting reflex is turned off.
4. Nausea drops within 15 to 30 minutes.

SAFETY WATCH

Constipation — common, especially if also taking opioids. · Headache. · Rare: can prolong the QT interval on ECG (a heart-rhythm marker) — use carefully if the patient has a known heart-rhythm problem or takes other QT-prolonging drugs.

Potassium citrate · Urinary alkalinizer

Raises the pH (makes the urine less acidic) and increases citrate (a chemical that binds calcium and stops it from clumping into crystals). Used to prevent NEW stones in people with uric-acid stones or low urinary citrate, not to treat an acute stone that is already formed and stuck.

1. Potassium citrate is absorbed in the gut and filtered by the kidney.
2. The citrate raises urine pH (makes it less acidic) and increases citrate concentration in the urine.

3. Higher citrate binds calcium ions so they cannot join with oxalate or phosphate to form crystals.
4. Uric acid dissolves better in alkaline urine, so uric-acid stones are less likely to form.

SAFETY WATCH

Can raise blood potassium — avoid if kidney function is poor or if taking potassium-sparing diuretics or ACE inhibitors. · Stomach upset or diarrhea — take with food. · Do not use if urine pH is already high (above 7) or if the patient has a urinary-tract infection with urease-producing bacteria (which already makes urine alkaline).

Red flags

- Fever in a patient who has a swollen, backed-up kidney (hydronephrosis) on imaging → Start IV antibiotics immediately and call urology within hours to drain the kidney, either by placing a thin tube through the bladder up past the stone (ureteral stent) or through the skin into the kidney (nephrostomy tube).
- No urine output (anuria) and creatinine rising in the blood → Emergency CT scan to confirm obstruction and urgent urology consultation to restore urine flow, usually with stents or drainage tubes.
- Stone larger than 10 millimeters (about the width of a small pea) → Refer to urology for removal, typically with shock waves that break the stone from outside the body (extracorporeal shock wave lithotripsy, ESWL) or a thin camera and tools passed through the bladder (ureteroscopy).
- Severe pain that does not get better even with strong IV pain medicines (like ketorolac or morphine) → Admit to the hospital for continuous pain control and urology evaluation, often leading to urgent intervention to relieve the blockage.

Nursing priorities

1. Give scheduled + PRN analgesia early — Colic pain is severe. Waiting causes suffering and prolongs vomiting.
2. Strain all urine and save any stone passed — Chemistry guides prevention strategy.
3. Monitor for fever and vital-sign trends — Sepsis in an obstructed infected system develops fast.
4. Push oral fluids once nausea is controlled — Dilutes the pee and helps stone passage.
5. Teach dietary prevention for next stone — Recurrence rate is 30–50% at 5 years without prevention.

Sources

- American Urological Association (AUA) Guideline on Surgical Management of Stones, 2016 (amended 2023)
- European Association of Urology (EAU) Guidelines on Urolithiasis, 2024
- UpToDate
- American College of Emergency Physicians (ACEP) Clinical Policy on Renal Colic

Last reviewed: 2026-02-28