Family physicians are critical in the diagnosis and management of patients presenting with urinary tract calculi. This common disorder afflicts approximately 10% of the general population. After their initial stone episode, more than 50% of patients will have at least one recurrence in their lifetime, with a recurrence rate of about 7% per year.

Diagnostic considerations

History and physical examination

Although recurrent urolithiasis may be asymptomatic, patients often present with symptoms similar to their first stone episode. Approximately 25% of patients with recurrent urinary calculi have a family history of urinary tract calculi. Common symptoms of renal or ureteral calculi include:

- dull flank ache,
- acute renal colic with or without nausea and/or vomiting,
- microscopic or gross hematuria or
- symptoms indicative of a urinary tract infection.

Infectious symptoms can often be localized to the lower urinary tract (suprapubic pain, irritative voiding symptoms) or upper urinary tract (flank pain with fever, chills, rigors).

In severe and potentially life-threatening cases of an obstructing stone, patients can present with systemic infectious symptoms, including hemodynamic instability (hypotension, tachycardia, tachypnea), mental status changes and oliguria or anuria. This symptom constellation requires urgent intervention with appropriate urinary tract drainage and...

Simon’s case

- Simon, 56, presents with mild, intermittent, left renal, colicky-type pain.
- He has a past history of urolithiasis and passed a stone four years ago.
- His pain is adequately controlled and a kidneys/ureters/bladder X-ray demonstrates a 9 mm x 5 mm calcification suspected of residing in the proximal left ureter.
- A computed tomography scan confirms a 9 mm proximal left ureteral stone with mild hydroureteronephrosis.
- A urology referral is made; extracorporeal shock wave lithotripsy and ureteroscopic laser lithotripsy, etc. options are discussed.
- He chooses ureteroscopy; his stone is fragmented using laser lithotripsy and is retrieved for analysis.
- Post-operatively, Simon is pain-free and follow-up imaging demonstrates that he is also stone-free.
- His stone analysis reveals a calcium oxalate monohydrate stone.
- He undergoes a metabolic stone workup three months later, which is normal other than a low 24-hour urinary volume (1,200 mL).
- Simon is advised to increase his oral fluid intake to at least 2,500 mL per day.
Kidney Stones

Table 1

<table>
<thead>
<tr>
<th>Domain</th>
<th>Important historic points</th>
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</thead>
<tbody>
<tr>
<td>Current signs and symptoms</td>
<td>Pain (back, flank, abdominal, inguinal, genital); lower urinary tract symptoms (frequency, urgency, nocturia); signs of generalized infection (fever, chills, rigors, malaise); gross hematuria; nausea and vomiting; oliguria or anuria</td>
</tr>
<tr>
<td>Past history of urinary tract calculi</td>
<td>Number of episodes; age of onset; symptoms; previous investigations; bloodwork, urine tests, stone analysis, radiologic; previous treatment (observation, dietary, pharmacologic, surgical); time of last followup for urolithiasis</td>
</tr>
<tr>
<td>Past urologic history</td>
<td>Renal insufficiency/failure; solitary kidney; transplant kidney; hydronephrosis; urologic surgery; urinary tract infections; recurrent, chronic, pyelonephritis; voiding dysfunction/neurogenic bladder</td>
</tr>
<tr>
<td>Past medical history</td>
<td>Metabolic disease; gout; inflammatory bowel disease; chronic diarrhea; granulomatous disease; sarcoidosis, tuberculosis; prolonged immobilization</td>
</tr>
<tr>
<td>Past surgical history</td>
<td>Bowel resection; pelvic surgery</td>
</tr>
<tr>
<td>Diet</td>
<td>Daily fluid intake; calcium and vitamin D intake (milk, vitamins); meat/protein intake; oxalate intake</td>
</tr>
<tr>
<td>Medications</td>
<td>Vitamin supplements; diuretics; antihypertensives; steroids; lithium</td>
</tr>
<tr>
<td>Family history</td>
<td>Urinary calculi; urologic disease; nephrolithic disease; metabolic disease (hyperparathyroidism, gout, hyperthyroidism)</td>
</tr>
</tbody>
</table>

What blood work is included in a metabolic stone workup?

Complete blood cell count, electrolytes, bicarbonate, blood urea nitrogen, creatinine, calcium (total and ionized), uric acid, total protein, albumin, magnesium, phosphate, parathyroid hormone

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referral to an acute care centre. Table 1 outlines the important history points to cover.

Physical examination in patients with recurrent stones in the elective, outpatient setting is usually non-contributory.

Although most recurrent urinary tract calculi form in the kidney, they may also form in the bladder when there is an obstruction of the bladder outlet or urethra, which may lead to intravesical urinary stasis. Bladder calculi may cause or exacerbate lower urinary tract symptoms and, in some cases, may even cause urinary retention.

Pediatric patients with recurrent urinary tract calculi must be investigated, as they often have an underlying metabolic or anatomic abnormality that predisposes them to urolithiasis. Tables 2 and 3 outline other indications for urologic referral and metabolic stone testing, respectively.

Investigations

Patients with recurrent urolithiasis require urine studies and bloodwork in order to determine any underlying metabolic abnormality that predisposes them to form recurrent stones.

Stone analysis is performed to determine the stone composition. Diagnostic imaging establishes the size and location of the stone(s), which impacts stone treatment. Diagnostic imaging tests include plain kidney/ureters/bladder (KUB) X-ray, intravenous pyelogram (IVP), ultrasound and computed tomography (CT) scan.

KUB is a reasonable starting point, as it is the least expensive and is readily available. CT scan-
Kidney Stones

Table 2
Indications for urologic consultation

<table>
<thead>
<tr>
<th>Urgency of consultation</th>
<th>Conditions</th>
</tr>
</thead>
</table>
| Urgent (i.e., hospital admission required) | Clinically unstable patient:  
- Signs and symptoms of infection  
- Uncontrollable pain  
- Uncontrollable nausea and vomiting  
Bilateral calculi with potentially obstructing ureteral calculus  
Solitary (anatomic or functional or transplant) kidney with potentially obstructing ureteral calculus  
Known renal insufficiency or failure with potentially obstructing ureteral calculus |
| Elective (i.e., outpatient assessment) | Recurrent urinary calculi  
Multiple calculi  
Large calculus unlikely to pass:  
- ≥ 6 mm in maximum dimension  
- Staghorn calculus  
Symptomatic calculus any size that has failed a trial of spontaneous passage after one month  
Any non-calcium oxalate calculus  
- Uric acid  
- Struvite  
- Cystine  
Patient age < 16 years  
Pregnancy  
Nephrocalcinosis  
History of genitourinary tract surgery  
Occupational requirement to be 100% stone-free (i.e., pilot, astronaut) |

FAQ
What urine studies are included in a metabolic stone workup?
- Urinalysis, urine microscopy for crystals, urine culture and sensitivity
- A 48-hour urine collection for urine volume, pH, creatinine, sodium, potassium, chloride, bicarbonate, calcium, magnesium, phosphate, oxalate, uric acid, citrate, protein, cystine, urine cyanide-nitroprusside test (for cystinuria), if indicated.

Table 3
Indications for metabolic stone testing

<table>
<thead>
<tr>
<th>Stone factors</th>
<th>Patient factors</th>
</tr>
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</table>
| Recurrent urinary calculi  
Multiple calculi  
Bilateral calculi  
Staghorn calculus  
Non-calcium oxalate stone composition  
Patient age < 16 years  
Solitary kidney, including renal transplant  
Family history of stone disease |
| Nephrocalcinosis  
Inflammatory bowel disease  
Occupation requires 100% stone-free status |
Kidney Stones

When is the optimal time to order a metabolic stone workup?
- At least two or three months after the most recent period of stone activity (symptoms or surgery) to allow the patient to resume normal baseline activity, diet and fluid intake.

<table>
<thead>
<tr>
<th>Stone type</th>
<th>Metabolic abnormality</th>
<th>Treatment and prevention strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any</td>
<td>Low urine volume, Urinary tract abnormalities (congenital or acquired)</td>
<td>• Increased fluid intake • Surgical intervention</td>
</tr>
<tr>
<td>Calcium oxalate +/-</td>
<td>Hypercalcemia and/or Hypercalciuria</td>
<td>• Potassium citrate • Treat underlying condition • Thiazide diuretic</td>
</tr>
<tr>
<td>Calcium phosphate</td>
<td>Hyperoxaluria</td>
<td>• Pyridoxine if gastrointestinal related • Decrease dietary oxalate intake</td>
</tr>
<tr>
<td>Calcium oxalate (pure)</td>
<td>Hypocitraturia</td>
<td>• Potassium citrate</td>
</tr>
<tr>
<td>Uric acid</td>
<td>Hyperuricemia and/or Hyperuricosuria</td>
<td>• Decrease dietary purine intake • Allopurinol • Potassium citrate • Sodium bicarbonate</td>
</tr>
<tr>
<td>Cystine</td>
<td>Cystinuria</td>
<td>• Low methionine diet • Restrict dietary sodium (&lt; 3 gm/day) • Potassium citrate • Sodium bicarbonate • Penicillamine • Captopril • Antibiotics • Ensure complete bladder emptying</td>
</tr>
<tr>
<td>Struvite</td>
<td>Urinary tract infection with urease-producing organism</td>
<td></td>
</tr>
</tbody>
</table>

Ultrasonography is also widely available and identifies the presence of hydronephrosis, which may be indicative of obstruction. However, it is not particularly sensitive in detecting mid and distal ureteral stones. Currently, a non-contrast helical CT scan is the most sensitive and specific, making it the “gold standard” imaging modality used in the diagnosis of urinary tract calculi.
**Kidney Stones**

**Treatment**

The first step in the prevention and treatment of recurrent urolithiasis is to increase the daily fluid intake to at least 2.5 L to 3 L per day. It has been shown that a urine output greater than 2 L per day will significantly decrease the risk of recurrent urinary calculi.

When possible, dietary modifications are also helpful. Restricting foods that are high in dietary oxalate (spinach, tea, chocolate, peanuts, rhubarb, cranberries, beetroots), purines (anchovies, brains, gravies, kidneys, liver, sardines, sweetbreads, beef, fish, turkey) or methionine (potatoes, tofu, broccoli, spinach, green peas, mushrooms, nuts) may be useful for calcium calciu

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**Take-home message**

1. Kidney stones have a very high recurrence rate
2. A metabolic stone work-up and specialist referral is recommended for all recurrent stone formers
3. Increasing daily fluid intake is the mainstay of long-term prevention of future stone episodes
oxalate, uric acid and cystine stones, respectively. Pharmacologic manipulation is useful when a metabolic abnormality that predisposes the patient to forming stones exists. Table 4 outlines medical treatments and prevention strategies for each major stone type.

Surgery is performed as indicated. Today, virtually all stones may be treated by a minimally invasive approach.

Our summary...

Urinary tract calculi are very common and many patients develop recurrent stones. Patients with recurrent urolithiasis should undergo metabolic testing and should be referred to a nephrologist or urologist. Investigation and treatment will depend on the presentation (i.e., acute versus chronic).

Regardless of the stone type, increasing fluid intake is critical in preventing future episodes and is the foundation of long-term management in most patients with recurrent kidney stones.

References available—contact *The Canadian Journal of Diagnosis* at diagnosis@sta.ca.