

Investigation and Prevention of kidney stones

Mr Jas Kalsi
Consultant Urologist

KIDNEY STONES

Kidney stones affect approximately 12 percent of men and 5 percent of women by age 70. Fortunately, treatment is available to effectively manage most stones. In addition, you can take steps to prevent kidney stones from recurring.

HOW KIDNEY STONES DEVELOP

A kidney stone can form when substances such as calcium, oxalate, cystine, or uric acid are at higher levels in the urine. Stones can also form if these substances are at normal levels, especially if the amount of urine made each day is low. The substances form crystals, which become anchored in the kidney and gradually increase in size, forming a kidney stone.

Typically, the stone will move through the urinary tract ([figure 1](#)) and is passed out of the body in the urine. A stone may cause pain if it becomes stuck and blocks the flow of urine. Large stones do not always pass on their own and sometimes require a procedure or surgery to remove them.

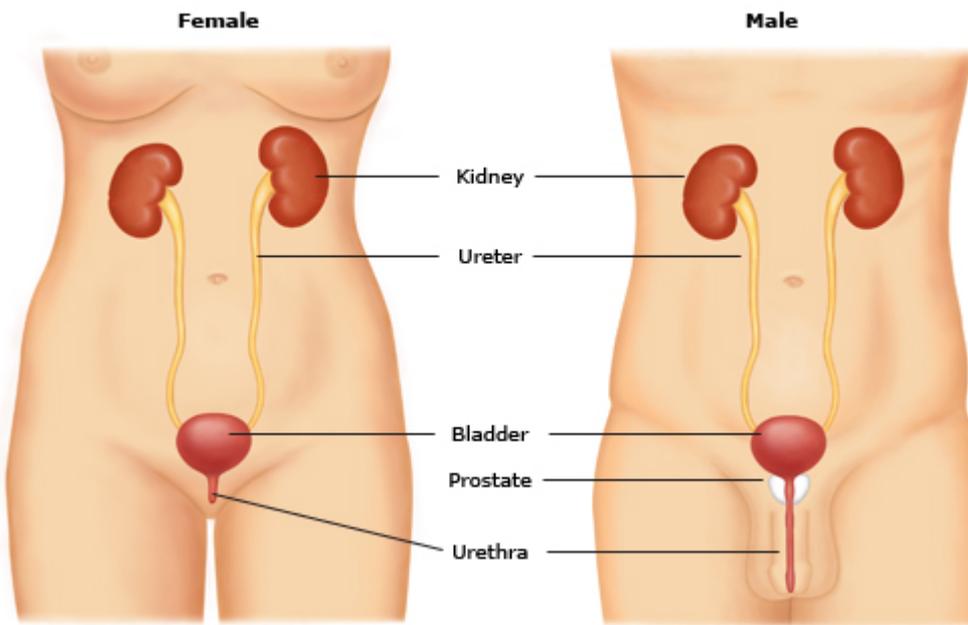


Figure 1. Urine is made by the kidneys. It passes from the kidneys into the bladder through two tubes called the ureters. Then it leaves the bladder through another tube, called the urethra.

RISK FACTORS

Certain diseases and habits can affect a person's risk for developing kidney stones. These include a past history or family history of kidney stones, certain dietary habits, underlying medical problems, certain medications, and dehydration ([table 1](#)).

Diet
Not drinking enough fluid
Diet with low levels of calcium
Use of calcium supplements
Diet with high levels of animal protein
Diet with high levels of sugars (sucrose, fructose)
Diet with low levels of phytate (found in wheat, rice, rye, barley, and bean products)
High sodium diet
Frequent spinach consumption
Other medical conditions
Primary hyperparathyroidism
Gout
Diabetes mellitus
Obesity
Crohn's disease
Gastric or intestinal bypass surgery

Table 1. Dietary factors and medical problems that increase the risk of kidney stones

SYMPTOMS

Blood in the urine — Most people with kidney stones will have blood in the urine (haematuria). The urine may be pink or red, or the blood may be visible only with urine dipstick testing or microscopic examination of the urine.

Gravel — You may pass "gravel" or small stones in your urine.

Other symptoms — Associated kidney stone symptoms include nausea or vomiting, pain with urination, and an urgent need to urinate.

Asymptomatic kidney stones — Some patients with kidney stones have no symptoms (asymptomatic). These kidney stones are usually found when an imaging study (such as an ultrasound, x-ray or CT scan) is performed for other purposes. Stones can remain in the kidneys for many years without ever causing symptoms.

DIAGNOSIS

Kidney stones are usually diagnosed based upon your symptoms, a physical examination, and imaging studies.

Computed tomography (CT) scan — A CT scan creates a three dimensional image of structures within the body. A particular type of CT scan (called noncontrast CTKUB) is often recommended if kidney stones are suspected. This is the 'gold standard' way of diagnosing the size and position of any stone in the renal tract.

Ultrasound — An ultrasound can also be used to detect kidney stones, although small stones or stones in the ureters may be missed. However, ultrasound is the procedure of choice for people who should avoid radiation, including pregnant women.

TREATMENT

Treatment of kidney stones depends upon the size and location of your stone, as well as your pain and ability to keep down fluids. If your stone is likely to pass, your pain is tolerable, and you are able to eat and drink, you can be treated at home.

If you have severe pain or nausea, you will need to be treated with stronger pain medications and IV fluids, which are often given in the hospital.

Medical treatment to aid stone passage

If there are no high risk features such as fever, vomiting and worsening renal function, you may be started on medical treatment at home to allow the stone to pass naturally. Treatment usually includes pain medication (non-steroidal anti-inflammatory drugs such as ibuprofen, diclofenac or naproxen), increased fluids (to drink) and a smooth muscle relaxant (Tamsulosin) until the stone is passed.

The likelihood of spontaneous passage of a ureteric stone is related to both stone size and location. Most stones ≤ 4 mm in diameter pass spontaneously. For stones larger than 4 mm in diameter, there is a progressive decrease in the spontaneous passage rate, which is unlikely with stones ≥ 8 mm in diameter. Proximal ureteral stones are also less likely to pass spontaneously.

Several different medical interventions may increase the stone passage rate of ureteric stones, including antispasmodic agents, calcium channel blockers and alpha blockers.

You will be given an out-patient appointment to be reviewed in clinic in 2-3 weeks with an X-ray on arrival.

If you develop a fever, severe pain or vomiting you must attend the local Accident and Emergency department without delay. This is because you may have developed a blockage or infection of your kidney.

TREATMENT

Failed medical treatment

You will be reviewed in clinic within 2-3 weeks with an X-ray on arrival. Stones larger than 8 millimetres rarely pass on their own and generally require a procedure to break up or remove the stone. Some smaller stones also may not pass. Several procedures are available.

Rigid and Flexible Ureteroscopy

Ureteroscopy is a procedure that uses a thin scope, which is passed through the urethra and bladder, into the ureter and kidney. This scope contains a camera and other instruments, which allows the urologist to see the stone and remove it, or to break it up into smaller pieces (Holmium laser) that can pass more easily. Ureteroscopy is often used to remove stones blocking the ureter, and sometimes for stones in the kidney.

Shock wave lithotripsy (ESWL)

Lithotripsy is particularly good for stones in the kidney and upper ureter. Lithotripsy may not be effective for treating large or hard stones. You may require medication to make you sleepy and reduce pain during treatment, although this depends upon the type of lithotripsy equipment used.

Lithotripsy is done by directing high-energy shock waves toward the stone. These pass through the skin and bodily tissues and release energy at the stone surface. This energy causes the stone to break into fragments that can be more easily passed.

Percutaneous nephrolithotomy (PCNL)

Very large (> 1.5cm) or complex stones, or stones resistant to shock wave lithotripsy, may require a minimally invasive surgical procedure to remove the stone. In this procedure, small instruments are passed through the skin (percutaneously) into the kidney to remove the stone.

For further detailed information please see ‘Management of renal and ureteric stones in Adults’.

KIDNEY STONE PREVENTION

After you have a kidney stone, you should have blood and urine tests to determine if you have certain health problems that increase the risk of kidney stones ([table 1](#)).

A treatable metabolic cause of stone formation can be detected in more than 95 percent of patients evaluated for stone disease.

A variety of medical treatments may correct the underlying metabolic defects responsible for stone formation, thereby reducing the occurrence of new stone formation. Examples for which controlled trials have demonstrated benefit include a high fluid intake for all forms of stone disease, a thiazide diuretic for hypercalciuria, [allopurinol](#) or potassium citrate for hyperuricosuria, and potassium citrate for hypocitraturia.

With medical treatment, it has been demonstrated that there is remission of stone disease in more than 75 percent and a reduced rate of stone passage in more than 94 percent of patients. Although it prevents new stone formation, medical therapy does not dissolve preexisting calcium stones.

If you passed and saved the stone, it should be analyzed to determine the type of stone. Based upon these test results, one or more of the following may be recommended:

- You may be given a medication to reduce the risk of future stones.
- You may be advised to make changes in your diet; the changes recommended will depend upon the type of kidney stone you have.

Ways to reduce the risk of kidney stones in the future

1. Drink more fluids to decrease the risk of another stone. The goal is to increase the amount of urine that flows through your kidneys and also to lower the concentrations of substances that promote stone formation. Experts recommend drinking enough fluid that you make about 2 litres of urine per day. Especially drink fruit and vegetable juices. Orange, grape and carrot juices are high in citrates which inhibit both a build-up of uric acid and also stop calcium salts from forming.
2. Avoid substances high in oxalates such as rhubarb, spinach and chocolate as well as adding excess salt to your diet.
3. Most kidney stones are compounds of calcium and most Europeans are calcium deficient. Instead of lowering calcium intake, reduce excess dietary phosphorous by avoiding carbonated soft drinks, especially colas. Soft drinks contain excessive quantities of phosphorous as phosphoric acid. This is the same acid that has been used by dentists to etch tooth enamel before applying sealant. Most Europeans get only about 500 mg of dietary calcium daily, and the RDA is 800 to 1200 mg/day.
4. A low calcium diet is associated with the formation of calcium stones (L. H. Smith, et al, "Medical Evaluation of Urolithiasis" *Urological Clinics of North America* 1:2, 241-260, June 1974)
5. For uric acid/purine stones (gout), REDUCE MEAT! Nutrition tables and textbooks indicate meats as the major dietary purine source. Increased vitamin C consumption helps by improving the urinary excretion of uric acid. (Cheraskin, et al, 1983).
6. Patient with cystine stones (only 1% of all kidney stones) should follow a low methionine diet.
7. Kidney stones are associated with high sugar intake, so eat less (or no) added sugar (J. A. Thom, et al "The Influence of Refined Carbohydrate on Urinary Calcium Excretion," *British Journal of Urology*, 50:7, 459-464, December, 1978)
8. Urinary tract infections can cause conditions that favour stone formation, such as overly concentrated urine (from fever sweating, vomiting or diarrhoea) and an alkaline pH. Avoiding infections with a low dose antibiotic may be helpful.

How does sodium in the diet affect kidney stone formation?

Sodium, often from salt, causes the kidneys to excrete more calcium into the urine. High concentrations of calcium in the urine combine with oxalate and phosphorus to form stones. Reducing sodium intake is preferred to reducing calcium intake.

The U.S. recommended dietary allowance (RDA) of sodium is 2,300 milligrams (mg), but Americans' intake averages 3,400 mg, according to the U.S. Department of Agriculture.¹ The risk of kidney stones increases with increased daily sodium consumption. People who form calcium oxalate or calcium phosphate stones should limit their intake to the U.S. RDA level, even if they take medications to prevent kidney stones.

¹U.S. Department of Agriculture and U.S. Department of Health and Human Services. *Dietary Guidelines for Americans, 2010*. 7th ed. Washington, D.C.: U.S. Government Printing Office; December 2010.

How can a person limit sodium intake?

Learning the sodium content of foods can help people control their sodium intake. Food labels provide information about sodium and other nutrients. Keeping a sodium diary can help a person limit sodium intake to 2,300 mg. When eating out, people should ask about the sodium content of the foods they order.

Some foods have such large amounts of sodium that a single serving provides a major portion of the RDA. Foods that contain high levels of sodium include

- hot dogs
- canned soups and vegetables
- processed frozen foods
- luncheon meats
- fast food

People who are trying to limit their sodium intake should check labels for ingredients and hidden sodium, such as

- monosodium glutamate, or MSG
- sodium bicarbonate, the chemical name for baking soda
- baking powder, which contains sodium bicarbonate and other chemicals
- disodium phosphate
- sodium alginate
- sodium nitrate or nitrite

How does animal protein in the diet affect kidney stone formation?

Meats and other animal protein—such as eggs and fish—contain purines, which break down into uric acid in the urine. Foods especially rich in purines include organ meats, such as liver. People who form uric acid stones should limit their meat consumption to 6 ounces each day.

Animal protein may also raise the risk of calcium stones by increasing the excretion of calcium and reducing the excretion of citrate into the urine. Citrate prevents kidney stones, but the acid in animal protein reduces the citrate in urine.

How does calcium in the diet affect kidney stone formation?

Calcium from food does not increase the risk of calcium oxalate stones. Calcium in the digestive tract binds to oxalate from food and keeps it from entering the blood, and then the urinary tract, where it can form stones. People who form calcium oxalate stones should include 800 mg of calcium in their diet every day, not only for kidney stone prevention but also to maintain bone density. A cup of low-fat milk contains 300 mg of calcium. Other dairy products such as

yogurt are also high in calcium. For people who have lactose intolerance and must avoid dairy products, orange juice fortified with calcium or dairy with reduced lactose content may be alternatives. Calcium supplements may increase the risk of calcium oxalate stones if they are not taken with food.

How does oxalate in the diet affect kidney stone formation?

Some of the oxalate in urine is made by the body. However, eating certain foods with high levels of oxalate can increase the amount of oxalate in the urine, where it combines with calcium to form calcium oxalate stones. Foods that have been shown to increase the amount of oxalate in urine include

- spinach
- rhubarb
- nuts
- wheat bran

Avoiding these foods may help reduce the amount of oxalate in the urine.

What diet plan should a person follow to prevent future kidney stones?

A dietitian can help a person plan meals that lower the risk of forming stones based on the type of stone the person formed in the past. A person with a history of kidney stones may want to talk to a dietitian who specializes in kidney stone prevention or nutrition for people with kidney problems.

A dietitian can also help overweight people plan meals to help them lose weight. Studies have shown that being overweight increases the risk of kidney stones, particularly uric acid stones. Diets that are low in carbohydrates have been shown to further increase the risk of uric acid stones and should be avoided.

Studies have shown the Dietary Approaches to Stop Hypertension (DASH) diet can reduce the risk of kidney stones. The DASH diet is high in fruits and vegetables, moderate in low-fat dairy products, and low in animal protein. More information about the DASH diet can be found on the National Heart, Lung, and Blood Institute's website at www.nhlbi.nih.gov/health/health-topics/topics/dash.

Points to Remember

- Kidney stones can form when substances in the urine—such as calcium, oxalate, and phosphorus—become highly concentrated. Diet is one of several factors that can promote or inhibit kidney stone formation.
- Four major types of kidney stones can form: calcium stones, uric acid stones, struvite stones, and cystine stones.
- Drinking enough fluid is the most important thing a person can do to prevent kidney stones.
- People who have had a kidney stone should drink enough water and other fluids to make at least 2 liters of urine a day.
- Sodium, often from salt, causes the kidneys to excrete more calcium into the urine. High concentrations of calcium in the urine combine with oxalate and phosphorus to form stones. Reducing sodium intake is preferred to reducing calcium intake.
- Meats and other animal protein—such as eggs and fish—contain purines, which break down into uric acid in the urine.
- Calcium from food does not increase the risk of calcium oxalate stones. Calcium in the digestive tract binds to oxalate from food and keeps it from entering the blood, and then the urinary tract, where it can form stones.
- A dietitian can help a person plan meals that lower the risk of forming stones based on the type of stone the person formed in the past.

