Kidney Stones

Blood in the urine (hematuria)

Hematuria refers to the presence of blood in the urine. It is important to investigate the cause of hematuria because rarely, it is caused by a serious condition, such as bladder cancer. Hematuria may be visible (called gross hematuria, when the urine appears brown or red) or may be seen only with a dipstick or microscopic examination of the urine (called microscopic hematuria).

Gross hematuria or discolored urine — Gross hematuria is suspected when the urine is red or brown. Very small amounts of blood in the urine can cause a color change, so the presence of discolored urine does not usually mean that a large amount of blood has been lost.

In women, the urine may be discolored due to vaginal bleeding. If this is suspected, a urine specimen should be obtained with a catheter or after the woman has inserted a vaginal tampon and washed the genital area thoroughly. If blood remains in the specimen, it is likely to be from a urinary and not a vaginal source.

The use of certain medicines, rare diseases, and eating beets can also cause the urine to be red or brown.

Microscopic hematuria — Hematuria may be discovered when blood is found during urinalysis, a test for several abnormalities in the urine done for other purposes. Urinalysis may be done for screening, to determine if there are abnormalities in a person who has no symptoms, or to check for abnormalities in a person who has pain with urination, urinary frequency, or other concerns.

Transient or persistent hematuria — When hematuria is found, it is important to determine if blood is present all the time (persistent hematuria), or is a temporary event (transient hematuria). Repeat urine specimens on several days may be needed to make this determination. Persistent hematuria, as well as transient or

intermittent hematuria in men over the age of 50, requires evaluation to determine the cause.

Transient microscopic hematuria is a common problem in adults. This was shown in one study of 1000 young men who had yearly urinalyses between the ages of 18 and 33; hematuria was seen in 39 percent on at least one occasion and 16 percent on two or more occasions. No obvious reason could be identified in most men. By comparison, persistent hematuria is more likely to be a symptom of an underlying disease.

Causes — a number of different conditions can cause hematuria. Some of the most common are:

- Bladder infection (also called urinary tract infection or acute cystitis)
- Inflammation, infection, or cancer of the prostate gland (for men)
- Kidney disease or infection
- Cancer of the bladder or kidney
- Urinary tract infection: Hematuria can be caused by an infection in any part of the urinary tract, most commonly the bladder (cystitis) or the kidney (pyelonephritis).
- Kidney stones
- Tumors in the kidney or bladder
- Exercise: Exercise hematuria is a harmless condition that produces blood in the urine after strenuous exercise. It is more common in males than females.
- Trauma: Traumatic injury to any part of the urinary tract from the kidneys to the urethral opening (the connection between the bladder and the outside world) can cause hematuria.
- Drugs: Hematuria can be caused by medications, such as blood thinners, including heparin, warfarin (Coumadin) or aspirin-type medications, penicillins, sulfa-containing drugs and cyclophosphamide (Cytoxan).

- Glomerulonephritis: Glomerulonephritis is a family of illnesses that are characterized by inflammation of the glomeruli, the filtering units of the kidneys. Glomerulonephritis is a rare complication of certain viral and bacterial infections (including strep throat). It can also occur in people with certain auto-immune diseases, systemic lupus erythematosus (lupus or SLE) and vasculitis. Sometimes there is no identifiable cause.
- Bleeding disorders: These include the family of hemophilias.

Other conditions or diseases can sometimes cause hematuria, related to other medical conditions or medications. No cause is found in some people with transient hematuria.

Evaluation — There are a number of tools available to determine the cause of hematuria. Not all are required for every patient. Decisions about whether to perform various diagnostic tests are based on many factors, such as the patient's history and age, and the preliminary findings from urinalysis.

- History — there are often clues from the patient's history that point to a specific diagnosis. For example, pain during urination suggests bladder infection, while pain on one side of the lower back suggests a kidney stone. The medical history will be considered before deciding which tests, if any, is needed.

- Analysis of urine — Laboratory analysis of the various components of the urine gives important clues about the cause of hematuria. This may include urine cytology, in which cells of the bladder and urinary tract, found in a sample of urine, are analyzed. In some cases, urine tests may be repeated every few months for several years.

- Blood tests — Blood tests may be used to look for evidence of kidney or other diseases that can cause hematuria.

- CT scans — Computed tomography, or CT scan, is a radiologic test that examines the structure of the kidneys, ureters, and

bladder. Kidney stones or abnormalities of the kidneys, ureter, and bladder can usually be seen with a CT scan. A dye is usually injected into a vein in the hand or arm during the test, which highlights any possible abnormalities.

- Kidney ultrasound — Ultrasonography of the kidney is an alternative to CT scan, and is preferred for people who are allergic to the contrast dye used in CT. Ultrasound uses sound waves to create a picture of the kidney's structure.

- Cystoscopy — Cystoscopy is a procedure that may be done in an office setting or as a day surgery procedure. A small tube with a camera is inserted into the bladder through the urethra, where urine usually exits the body. A numbing gel is applied before the tube is inserted, which decreases discomfort.

  The physician examines the lining of the bladder to determine if there are any abnormalities. If abnormal tissue is seen, a biopsy can be taken. The biopsy is examined with a microscope to determine if abnormal or cancerous cells are present. Biopsy is only done during surgery, after a patient receives sedative medication to prevent pain.

- Renal biopsy — A small piece of tissue from the kidney is removed and is examined for signs of kidney disease. A full description of renal biopsy is available separately.

Treatment — there is no specific treatment for hematuria. Rather, treatment is aimed at the underlying cause.

Follow up testing — if no cause is found, follow-up urine cytology and urinalyses is recommended for patients at high risk for cancer. A number of factors increase a person's risk of bladder cancer; include age greater than 50 years, cigarette smoking, and chemical exposure. Some healthcare providers also recommend repeat ultrasonography and cystoscopy at one year in high-risk patients with persistent hematuria. On the other hand, low-risk patients with persistent

microscopic hematuria of unknown causes can usually be followed with periodic urinalysis and urine cytology.

Symptoms

By itself, hematuria rarely causes symptoms. One exception is when the bladder has so much blood in it that clots form, and the flow of urine is blocked. This can cause pain at the site of the blockage in the lower pelvis. Symptoms usually come from the cause of the hematuria, and vary depending on the condition:

- Glomerulonephritis: If glomerulonephritis is not severe, it may not cause any symptoms. If symptoms appear, they can include swelling, especially in the lower extremities, reduced urination, and high blood pressure.
- Kidney or bladder infection: Symptoms depend on the site of infection, but can include intense pain on one side of the mid-back, fever, shaking chills, nausea and vomiting, pain above the pubic or bladder region, foul-smelling urine, the need to urinate more often than normal, and pain or discomfort during urination.
- Prostate infection: There can be pain in the lower back or in the area between the scrotum and anus, pain during ejaculation, blood in the semen, and, sometimes, fever and chills.
- Tumor in the kidney or bladder: Most kidney and bladder cancers grow without causing any pain or discomfort. When symptoms develop, the most common are abdominal pain, more frequent urination and pain at the end of urination.
- Kidney stones: When a kidney stone becomes trapped in one of the ureters (the narrow tubes connecting each kidney to the bladder), it can cause severe pain in the back, side or groin, nausea and vomiting, or painful and frequent urination.
- Bleeding disorders: Bleeding disorders tend to cause abnormal bleeding throughout the body, not just into the urine. Depending on the specific bleeding problem, symptoms can include abnormal bruising, prolonged bleeding from cuts,

bleeding in the skin, bleeding into the joints or gastrointestinal tract (causing black, tarry stools or bright red blood in the stool), or gum bleeding even with gentle flossing or brushing.
- Trauma: There often will be signs of traumatic injury to the body surface, such as bruises, swelling, punctures and open wounds.

Diagnosis

Your health care professional will want a sample of your urine to confirm that you have hematuria. In women, blood can get into the urine during menstruation. Your doctor may want to repeat the urine test between periods.

Once it has been confirmed that you have hematuria, he will ask about your medical history and your family's medical history, especially any history of kidney disease, bladder problems or bleeding disorders. Your doctor also will ask about any recent trauma or strenuous exercise, recent viral or bacterial infections, the medications you take, and your symptoms, including more frequent urination, pain with urination and pain in your side.

Your doctor also will examine you. He or she will take your temperature and blood pressure, and will see if you have pain or discomfort in your side or over your bladder. The doctor may recommend that women undergo a pelvic examination, and men undergo a prostate examination.

Your doctor will ask you for a fresh urine sample for a urinalysis. Urine is analyzed in the laboratory to look for protein, white cells and red cells to identify a kidney or bladder infection, or kidney inflammation (glomerulonephritis).

Then, depending on the suspected cause of your hematuria, additional testing may include:

- Urine culture: In this test, a sample of urine is monitored to see if bacteria grow. This test is used to confirm a kidney or bladder infection.
- CT scan of the kidneys, ureters and bladder: In this X-ray test, a dye (also called a contrast medium) is injected into an arm vein. The dye collects in the kidneys and is excreted in the urine, providing an outline of the entire urinary system. An IVP is particularly helpful for identifying kidney stones, though other problems, such as a tumor, can be detected with this test.
- Ultrasound: This test uses sound waves to help establish whether a kidney mass is a non-cancerous (benign), fluid-filled cyst or a solid mass, such as a cancerous tumor. Ultrasound also can identify kidney stones.
- Cystoscopy: In this test, the doctor inserts a flexible telescope into the urethra and passes it into the bladder to inspect the bladder lining for tumors or other problems. This test usually is done with local anesthesia and sedation.
- Blood tests: These can check for signs of urinary tract infection, kidney failure, anemia (which often accompanies kidney problems), bleeding disorders, or abnormally high levels of blood chemicals that can encourage the formation of kidney stones.

Additional testing for conditions causing kidney inflammation (such as lupus) may be recommended, depending on the findings of the routine blood and urine tests.

Expected Duration

How long hematuria lasts depends on its underlying cause. For example, hematuria related to strenuous exercise typically goes away on its own within 24 to 48 hours. Hematuria resulting from a urinary tract infection will end when the infection is cured. Hematuria related to a kidney stone will clear after the stone is passed or removed.

Prevention

To prevent hematuria related to strenuous exercise, switch to a less-intense exercise program. In general, you can help to prevent other forms of hematuria by following a lifestyle that fosters a healthy urinary tract:

- Stay well hydrated. Drink about eight glasses of fluid daily (more during hot weather).
- Avoid smoking cigarettes, which are linked to urinary tract cancers.

Treatment

The treatment of hematuria depends on its cause. In general, people with exercise-related hematuria do not need any treatment other than to modify their exercise programs. People with drug-related hematuria will improve if they stop taking the medication that caused the problem. Antibiotics typically will cure infection-related hematuria. For other causes of hematuria, treatment may be more complex:

- **Kidney stones:** Smaller stones sometimes can be flushed from the urinary tract by drinking lots of fluids. Larger stones may require surgery or lithotripsy, a procedure that breaks up the stone.
- **Trauma:** Treatment depends on the type and severity of injuries. In severe cases, surgery may be necessary.
- **Tumor in bladder or kidney:** Treatment is determined by the type of cancer and how much the cancer has spread (its stage), as well as by the patient's age, general health and personal preferences. The primary types of treatment are surgery, chemotherapy, radiation therapy and immunotherapy, a type of treatment that stimulates the immune system to fight cancer.

- **Glomerulonephritis:** Treatment may include antibiotics to treat any infection, medications called diuretics that help to

increase the amount of urine excreted from the body, medications to control high blood pressure and dietary changes to reduce the work of the kidneys. However, children who develop glomerulonephritis after a streptococcal infection often recover without any treatment. If it is caused by an autoimmune disorder, such as lupus, medications to suppress the immune system, including corticosteroids or cyclophosphamide (Cytoxan, Neosar), may be prescribed.

- **Bleeding disorders:** Treatment depends on the specific type of bleeding disorder. Patients with hemophilia can be treated with infusions of clotting factors or with fresh frozen plasma, a type of transfusion that provides missing factors.

Call your doctor immediately if you notice blood in your urine or if your urine turns the color of cola. You should also call your health care professional if you have fever or pain in the lower abdomen or side.

Prognosis

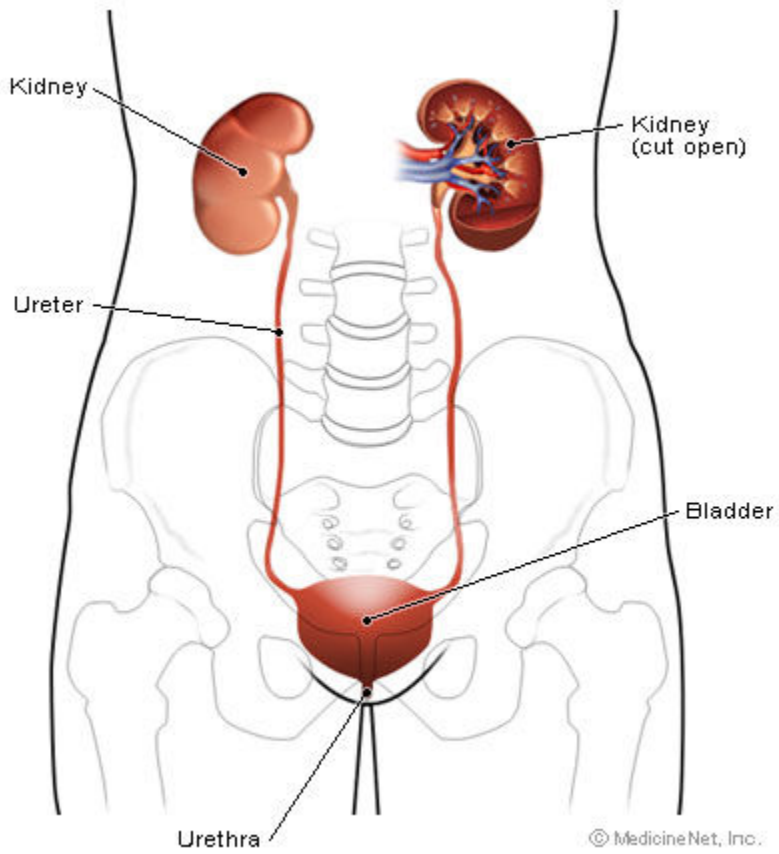
Most people whose hematuria is related to exercise, medication, kidney stones, urinary tract infection or prostatitis have an excellent outlook for complete recovery.

Children with hematuria resulting from glomerulonephritis usually recover completely if their illness is mild or if it develops after a strep infection.

Adults with glomerulonephritis are less likely to recover on their own, although the outlook depends on the specific type of glomerulonephritis. More severe forms of the disease eventually can lead to chronic kidney failure.

For people with kidney or bladder cancer, the outlook depends on the stage and type of tumor. In general, if a kidney or bladder tumor is diagnosed early, the cancer often can be cured.

Although people with hemophilia may have repeated bleeding episodes (including bleeding into joints, internal organs and other parts of the body), recent advances in treatment have achieved a near-normal lifespan for many patients.



How Kidney stones develop — A brief overview of the anatomy of the urinary tract will help in the understanding of kidney stones. The urinary tract is composed of two kidneys and ureters, a bladder, and a urethra (show figure 1). Urine is produced by the kidneys, which are located towards the middle of the back, below the ribs.

The kidneys remove waste products and excess fluid from the blood and convert this to urine. The urine passes out of the kidney through small tubules into the hollow portion of the kidney (renal pelvis) and then into the ureter, a narrow tube connecting the kidney to the bladder. The urine collects in the bladder until it passes out of the body through the urethra.

A kidney stone can form when substances such as calcium, oxalate, cystine, or uric acid are at high levels in the urine, but stones can also form if these substances are at normal levels. 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 to be expelled in the urine. A larger stone may cause pain if it becomes lodged in the urinary tract and obstructs the flow of urine. Occasionally, a stone may not pass into the ureters and can enlarge to fill the entire renal pelvis, which can damage the kidney if it produces infection or obstruction.

Most kidney stones are formed of calcium-containing material, primarily calcium oxalate and less commonly as calcium phosphate. Stones can also be made of other substances, such as uric acid, struvite (magnesium ammonium phosphate), or cystine. Knowing the stone composition is important as this information may influence the treatment.

Risk factors — certain diseases and habits can affect a person's risk for developing kidney stones.

History of kidney stones — Patients who have had a kidney stone in the past or have a family history of stones have the highest risk of a future stone. The likelihood of forming a second stone is about 5 to 10 percent at one year and 50 percent or higher at 10 years.

Dietary risk factors — the amount and type of food and drink that a person consumes can play an important role in the development of kidney stones.

- Low fluid intake — the amount of fluids a person drinks directly affects the amount of urine that is made. Drinking a small amount of fluids means that less urine is made, compared to if more liquids are consumed. Making less urine can increase the risk of stone formation because the concentration of stone-

forming substances in the urine is higher. Increasing fluid intake can reduce the risk of recurrent stones. One expert recommends drinking enough fluids so that the kidneys make approximately 2 liters of urine per day.

- Type of fluid — the type of fluid consumed may also be important, although data are sometimes conflicting. Grapefruit juice has been associated with an increased risk of kidney stones while coffee and tea may lower risk of stone formation. Beer and wine do not usually increase the risk of kidney stones.

- Calcium — there is little evidence that consuming large amounts of calcium (from foods and drinks) increases the risk of kidney stones or that consuming small amounts of calcium decreases the risk. However, avoiding dairy products is likely to increase the risk of kidney stones. An individual should consume the amount of calcium that is recommended for bone health based upon their age and gender.

On the other hand, use of calcium supplements may increase the risk of kidney stones in susceptible individuals by raising the level of calcium in the urine. This is particularly true if the supplement is taken between meals or at bedtime. People with a history of kidney stones should consult their healthcare provider about the risks and benefits of taking a calcium supplement.

- Phytate — Phytate is a substance found inside the husk of whole grains and cereals. Increased amounts of dietary phytate may lower the risk of stone formation, although it is not clear how this occurs. Phytate is found in wheat, rice, rye, barley, and bean products.

- Animal protein — It is not clear if eating a diet with high levels of animal protein increases the risk of calcium oxalate stone formation.

- Sucrose — Sucrose, commonly known as table sugar, is found in many prepared foods. Higher sucrose intake is associated with an increased risk of stone formation in women.

Medical conditions — some medical conditions are associated with an increased risk for stone formation, including the following:

- Conditions that increase the absorption of oxalate from the gastrointestinal tract (like short bowel syndrome, chronic diarrhea, or previous bowel surgery or gastric bypass surgery).

- Conditions that increase the chance of urinary tract infection, such as anatomic abnormalities of the kidneys or ureters, or difficulties with bladder emptying.

- Hyperparathyroidism and sarcoidosis, which can be associated with high blood levels of calcium

- Gout, which may result in acidic (low pH) urine.

- Diabetes, which may be associated with increased calcium excretion in the urine.

- Cystinuria, an inherited condition that is associated with an increased level of cystine in the urine

Medications — some medications that promote formation of urine crystals increase the risk of stone formation. Excessive intake of vitamin C (more than 1000 milligrams per day) can promote calcium oxalate stone formation.

Diarrhea and dehydration — Uric acid stones are sometimes seen in patients who have chronic diarrhea, because of their concentrated, acidic urine. People who are predisposed to developing stones have an increased risk of stone formation if they become dehydrated. This includes patients who engage in heavy physical exercise (such as marathon running).

Symptoms — Symptoms of a kidney stone occur when the stone passes from the kidney into the ureter (the tube that leads from the kidney to the bladder). Pain, blood in the urine (hematuria), passing small stones in the urine ("gravel"), nausea or vomiting, and the urgent need to urinate are common symptoms of kidney stones.

Pain — Pain is the most common symptom and can range from a mild and barely noticeable ache to discomfort that is so intense it requires hospitalization. Pain that occurs when the stone moves into the ureter is probably caused by stretching of the tissues surrounding the kidney; pain may also be related to blockage of urine flow.

Typically, the pain waxes and wanes in severity. Waves of severe pain, known as renal colic, usually last 20 to 60 minutes, although less severe pain can be present between episodes of renal colic.

Pain occurs on the side of the body where the stone is located. The area that is painful depends upon the location of the stone, which may change as the stone moves. A stone that obstructs the upper ureter or kidney leads to flank pain (pain in the side, between the ribs and the hip) or tenderness. A stone that obstructs the lower portion of the ureter causes pain in the lower abdomen, which can spread to the genital area.

Hematuria — Hematuria (blood in the urine) occurs in most patients with kidney stones. The blood may be visible to the patient as pink or reddish urine, or may be visible only by urine dipstick testing or microscopic examination of the urine.

Gravel — Patients may pass "gravel" or small stones. Uric acid stones, in particular, are more likely to cause gravel and can also cause obstruction.

Other symptoms — other symptoms include nausea or vomiting, pain with urination, and an urgent need to urinate. In some patients, the stone becomes stuck in the ureter, leading to persistent obstruction and possible kidney infection.

Staghorn calculi are irregularly shaped stones with protruding branches. These stones can grow to fill all or part of the renal pelvis, and are too large to pass through the ureters. Infection or obstruction from these large stones may lead to kidney damage if they are not removed.

Asymptomatic kidney stones — many patients with kidney stones have no symptoms (asymptomatic means without symptoms). These stones may be found when an imaging study (such as an ultrasound, x-ray or CT scan) is performed in a person with a prior history of stones, or when such a study is done for other purposes. Asymptomatic patients can remain symptom-free for years, although those with a history of stones are more likely to develop symptoms.

Diagnosis — Clinical symptoms, laboratory tests, and imaging studies may be used to diagnose a kidney stone. A sudden onset of flank pain and hematuria (blood in the urine) are particularly suggestive of a kidney stone. Analysis of a urine sample should be performed to determine if blood or stone crystals are present. An imaging test is typically performed to confirm the presence of a stone and to rule out other conditions, especially if the patient has no previous history of stones. Computed tomography (CT scan) is the preferred diagnostic test in most patients.

Computed tomography (CT) scan — A CT scan creates a three dimensional image of structures within the body. A particular type of CT scan (called non-contrast helical CT) can visualize almost all kidney stones (including those that are not seen with the other imaging tests), and can determine if there is obstruction to urine flow within the urinary tract. This test is the best one for determining if a kidney stone is present, although it may not be necessary if a stone has been detected with another test.

Ultrasonography — Ultrasonography (the use of sound waves to visualize body structures) can also be used to detect stones, although small stones or stones in the ureters may be missed. It is the

procedure of choice for patients who should avoid radiation, including pregnant women.

Abdominal x-ray — many types of kidney stones can be seen on standard abdominal x-ray (called KUB, kidneys, ureter, bladder). However, certain stones, such as uric acid stones and small stones, may not be seen. As a result, another test, such as a CT scan, may be required if a kidney stone is likely but the abdominal x-ray is negative.

Intravenous pyelogram (IVP) — In an IVP, a radio opaque dye (one that is seen on x-ray) is injected into a vein. The dye collects in and is excreted by the kidneys. As the dye passes through the kidney and into the bladder, the urinary tract and any kidney stones are visible on x-ray. Although most kidney stones can often be detected by IVP, there is a small risk of having an allergic reaction to the dye.

Laboratory tests — Blood and urine tests are usually recommended after a person is diagnosed with kidney stones to determine if an underlying medical problem is present. Some medical problems (eg, hyperparathyroidism) increase the risk of kidney stones, especially if the problem is unrecognized or untreated.

Treatment – Initial treatment for symptomatic kidney stones is similar for all patients. However, measures to prevent future stones vary depending upon a person's risk of recurrence.

Initial treatment — during the initial phase of kidney stone symptoms, many patients require only pain medication and fluids until the stone is passed. Nonsteroidal anti inflammatory drugs (NSAIDs, such as ibuprofen or naproxen) may be prescribed for pain and can be taken in pill form.

Medication may be given into a vein if the patient is too nauseous to tolerate pills. If the pain is not controlled by an NSAID, narcotics (such as morphine) may be given. Fluids are recommended (either by mouth or in a vein) to increase urine flow and facilitate passage of the

stone. Other medications, such as nifedipine or tamsulosin, may also be recommended to speed the passage of ureteral stones.

Patients who are able to take oral medications and fluids are usually managed at home. However, hospitalization may be required if the pain is severe or if the patient cannot drink fluids.

Patients are often asked to strain their urine to recover the stone; it can then be analyzed in a laboratory to determine the type of stone. Once the stone is passed, an imaging test is sometimes performed to confirm that passage is complete and that no fragments or additional stones remain. Stones smaller than five millimeters and even those up to 9 or 10 millimeters, often pass on their own without requiring a procedure.

If the stone does not pass — Stones larger than 9 or 10 millimeters rarely pass on their own and generally require treatment. Several procedures are available.

Shock wave lithotripsy (SWL) — SWL is the treatment of choice in many patients who need help passing a stone, and is particularly good for stones in the renal pelvis and upper ureter. SWL requires an x-ray or ultrasound to pinpoint the location of the stone. A high-energy shock wave is then directed toward the stone, passing through the skin and bodily tissues and causing a release of energy at the stone surface. This energy causes the stone to break into fragments that can be more easily passed.

SWL therapy may not be effective for treating large, hard, or complex stones (such as staghorn calculi).

Percutaneous nephrolithotomy (PNL) — extremely large 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 telescopic instruments are passed through the skin (percutaneously) into the kidney to remove the stone.

Ureteroscopy — Ureteroscopy is often used to remove stones obstructing the middle and lower portion of the ureter. In this procedure, a very small telescopic instrument is passed through the urethra and bladder, into the ureter and kidney. This scope contains a camera and other instruments, which allows the physician to visualize the obstructing stone and remove it, or to break it up into smaller pieces that can pass more easily.

Treatment of asymptomatic stones — Patients with asymptomatic stones may be treated, depending upon the size and location of the stone. Other factors are considered in deciding whether to treat the stone, including the patient's occupation (eg, pilot, frequent traveler, local worker) and their ability to easily receive treatment. Patients who might have difficulty receiving prompt treatment are more likely to be treated before they develop symptoms.

Regardless of the decision to treat or not, a person who is found to have a kidney stone should have blood tests to determine if any underlying medical problems are present.

Prevention — a number of steps can be taken to decrease the chance that another stone will develop.

Prevention after the first stone — after a patient has had a kidney stone, blood and urine tests are often performed to identify factors that may contribute to stone formation, particularly if the patient has any condition that predisposes them to recurrent stones. If the stone was passed and saved, it should be analyzed to determine the type of stone. Based upon these test results, medications may be prescribed to prevent the formation of similar stones.

Drinking more fluids may decrease the risk of another stone. The goal is to increase the amount of urine that flows through the kidneys and ureter, and also to lower the concentrations of substances that promote stone formation. Changes in the diet may also be recommended.

An abdominal x-ray or ultrasound may be performed one year after the first stone to determine if there are any new stones. If no new stones are seen, or if previous stones are the same size, the x-ray or ultrasound may be repeated every one to two years thereafter.

Prevention of recurrent stones — more extensive testing may be recommended for people who have had one or more previous kidney stones or for those with a family history of stones. Imaging studies, such as an IVP or CT scan, if not already done, may be performed to search for stones that are not causing any symptoms, and also to determine if there are abnormalities in the structure (shape, size) of the kidneys or ureters that could increase the risk of stone formation.

Summary

- A kidney stone can form when there are normal or high levels of certain substances in the urine. These substances can form crystals. Crystals become attached to the kidney and gradually increase in size, forming a stone.

- Eventually, the stone moves through the urinary tract and is passed in the urine. Or, the stone can remain in the urinary tract, blocking urine flow, which can cause pain.

- 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.

- The most common symptom of a kidney stone is pain; other symptoms include hematuria (blood in the urine), passing small stones, nausea, vomiting, pain with urination, and an urgent need to urinate. Many patients with kidney stones have no symptoms.

- Testing is usually needed to diagnose a kidney stone. Computed tomography (CT scan) is the preferred test for most patients.

- Treatment usually includes pain medication and increased fluids (to drink) until the stone is passed. Over the counter pain medication (eg, ibuprofen) may be helpful. If the pain is not controlled, a stronger medication (narcotic) may be needed.

- Small stones (less than 5 millimeters) usually pass without treatment. Larger stones (greater than 9 millimeters) rarely pass out on their own. Treatment for larger stones is usually done in a hospital.

- Further testing is recommended for patients who have kidney stones several times in their life. Tests help to determine if an illness is causing kidney stones to form. Medications may be prescribed to prevent future stones. Drinking more fluids and changing the diet can help to prevent future kidney stones.

Kidney stones in children

Fortunately, most children who develop kidney stones recover without any long-term complications. Stones are less common in children than in adults, although the number of children who develop stones is unclear. Most children who develop kidney stones have an underlying condition that increases their risk of stones, although some children develop a stone for unknown reasons. Some children, particularly young children, do not have any symptoms and the kidney stone is found when an imaging test (eg, x-ray) is done for another reason.

Pain — Pain is the most common symptom of a kidney stone. Pain can range from a mild and barely noticeable ache to intense discomfort. The likelihood that the child will feel pain depends somewhat upon the child's age; adolescents are more likely to have pain than young children. Younger children may not be able to say exactly where they feel pain.

Hematuria — Hematuria (blood in the urine) occurs in 30 to 50 percent of children with kidney stones. The urine may appear pink or

red-colored, or the blood may be visible only when the urine is analyzed in a laboratory.

Other symptoms — other common symptoms include nausea or vomiting, pain with urination, and an urgent need to urinate. Pain with urination and an urgent need to urinate can also occur when a child has a urinary tract infection. An evaluation is needed to distinguish between a urinary tract infection and a kidney stone. However, urinary tract infections are often seen in children with kidney stones.

Risk Factors — certain factors can increase a child's risk of developing kidney stones.

- History of kidney stones — Children who have had a kidney stone in the past have the highest risk of developing a stone in the future. Children who have one episode of kidney stones are usually advised to follow preventive measures to decrease the risk of developing a stone in the future.

- Low fluid intake — the amount of fluids a child drinks directly affects the amount of urine that is made. Drinking a small amount of fluids means that less urine is made, which increases the concentration of stone-forming substances in the urine. Increasing fluid intake can reduce the risk of recurrent stones.

- Diet high in animal protein — Children who eat a diet with high levels of animal protein (eg, beef, pork, lamb, chicken) may have an increased risk of developing calcium oxalate stones, especially if the child has difficulties with intestinal absorption. However, normal amounts of protein are essential for growth and do not increase the risk of forming kidney stones.

- Ketogenic diet — Diets that include a very small amount of carbohydrates, called ketogenic diets, can increase the risk of

kidney stones. Ketogenic diets are sometimes used to treat seizure disorders.

- Cystic fibrosis — Children with cystic fibrosis are at higher risk of developing kidney stones.

- Urinary tract abnormalities — Anatomic abnormalities of the kidneys or ureters, or difficulties with bladder emptying, increase the risk of developing a kidney stone.

- Medications — some medications promote formation of urine crystals. These include furosemide, acetazolamide, and allopurinol.

- Inherited disorders — several uncommon inherited disorders can increase a child's risk of developing kidney stones. Testing for these disorders may be recommended in some cases.

Diagnosis

Urine tests — two urine tests are recommended for children who are suspected of having a kidney stone. This includes a urine culture, to determine if the child has a urinary tract infection, and a urinalysis, which can determine if microscopic crystals are present in the urine.

Imaging tests — to confirm the presence of a kidney stone, an imaging test such as a CT scan, ultrasound, or x-ray, is necessary. The imaging test can also help to determine if there are abnormalities of the urinary tract, which would increase the risk for future stones. Computed tomography (CT scan) is the preferred test in most cases. There is some concern about exposing a child to excessive amounts of radiation, especially if the CT scanner uses an adult dose of radiation. In many cases, the amount of radiation can be reduced, based upon the child's size and weight. If this is not possible, another imaging test, such as ultrasound, may be recommended.

Ultrasonography — Ultrasonography (the use of sound waves to visualize body structures) can also be used to detect stones, although small stones and stones in the ureters may be missed. However, ultrasound is the procedure of choice for children who should avoid radiation, such as in pregnant girls or if the dose of radiation in a CT scanner cannot be adjusted for small children.

Abdominal x-ray — many types of kidney stones can be seen on standard abdominal x-ray (called KUB, kidneys, ureter, bladder). However, certain stones, such as uric acid stones and small stones, may not be seen. As a result, another test, such as a CT scan, may be required if a kidney stone is likely but the abdominal x-ray is negative.

Treatment

Treatment at home — If the stone is small, pain is manageable, and the child is otherwise healthy, treatment may be provided at home. Stones smaller than 5 millimeters (0.2 inches) often pass on their own without requiring a procedure, even in young children.

Pain is usually managed with a nonsteroidal anti-inflammatory drug such as ibuprofen. In addition, the child is encouraged to drink an increased amount of fluids to help flush the stone out of the kidney, ureter, or bladder.

The parent/child will be asked to strain the child's urine for a few days, until the stone passes. If a stone or stone fragment is passed, it can be analyzed in a laboratory to determine the type; this can help to guide future treatment. Once the stone is passed, an imaging test (usually ultrasound) of the urinary tract may be performed to confirm that the stone was passed and that no fragments or additional stones remain.

Hospital treatment — in some cases, the child will need to be hospitalized for treatment. The following are the two most common reasons for hospitalization:

- The urinary tract is blocked (obstructed) by the stone, preventing the normal flow of urine. If the obstruction is not treated quickly, it can cause permanent damage to the kidneys.

- The child's pain cannot be controlled because it is severe or because the child is vomiting

In the hospital, the child will be given intravenous (IV) pain medications and IV fluids. If the stone is small, this treatment may be continued for several days, until the stone passes. During this time, the location of the stone is usually monitored with ultrasound and the child's urine will be strained to recover any stone or stone fragments that pass.

Other standard treatments to eliminate the stone also apply to children.

The percentage of children who have no remaining stones after PN is between 70 and 90 percent, depending upon the experience of the clinician, the size of the stones, and the presence of an underlying abnormality in the kidney, ureter, or bladder. The percentage of children who have no remaining stones after ureteroscopy is approximately 90 percent.

Prognosis — There are inadequate data about the long term prognosis of children who develop kidney stones. The chances of future kidney stones, kidney damage, and other complications depend largely upon the child's age during the first episode of kidney stones and the underlying reason that the stone developed.

Prevention— Children who develop a kidney stone have a significant chance of developing stones in the future. Studies have estimated the chances to be between 30 and 65 percen. However, a number of steps can decrease the chance that another stone will develop.

Testing

Blood and urine — after a child has had a kidney stone, blood and urine tests are performed to identify metabolic disorders or other factors that can increase the risk of future stone formation. Testing is not done until the child is at home, walking and playing normally, eating a normal diet, and has finished any treatment for urinary tract infection. Urine testing may require the child/parent to collect the urine for 24 hours. If it is not possible to collect a 24-hour urine specimen because the child is not toilet trained, a single urine sample may be collected instead. In this case, the urine is collected with a bag that is gently adhered around the child's genitals.

Testing can reveal one or more of the following conditions:

- Hypercalciuria (high level of urinary calcium)
- Hyperoxaluria (high level of urinary oxalate)
- Hyperuricosuria (high level of urinary urate)
- Cystinuria (high level of urinary cystine)
- Hypocitraturia (low level of urinary citrate)

Stone testing — if the stone was passed and saved, it should be analyzed to determine the type of stone. The frequency of various types of stones in children is listed below:

- Calcium oxalate — 45 to 65 percent
- Calcium phosphate — 14 to 30 percent
- Struvite — 13 percent
- Cystine — 5 percent
- Uric acid — 4 percent
- Mixed or miscellaneous — 4 percent

Based upon analysis of the stone, one or more interventions may be recommended to reduce the risk of future stone formation.

Increase fluid intake — drinking more fluids can help to decrease the risk of forming all types of kidney stones. The goal is to increase the amount of urine that flows through the kidneys and ureters and to lower the concentration of substances that promote stone formation.

The volumes recommended below represent the amount of urine a child should make per day, depending upon their age. The child's fluid intake should be increased if he or she makes less than this amount of urine per 24 hours.

- Infants — ≥ 750 mL (> 25 ounces or 3 cups)
- Children younger than five years of age — ≥ 1000 mL (> 33 ounces or 4 cups)
- Children between five and ten years of age — ≥ 1500 mL (> 50 ounces or 6 cups)
- Children greater than 10 years of age — ≥ 2000 mL (> 66 ounces or 8 cups)

Interventions — one or more interventions may be recommended to decrease the concentration of stone-promoting substances in the urine.

Hypercalciuria — Children with increased levels of calcium in the urine may be advised to increase fluid intake and follow these dietary measures:

- Eat a low-sodium diet

- The amount of dietary calcium recommended per day depends upon the child's age: 500 mg/day for children 1 to 3 years, 800 mg/day for children 4 to 8 years, and 1300 mg/day for children 9 years and older. Check the amount of calcium in selected foods. Consuming excessive amounts of dietary calcium is not recommended. On the other hand, limiting dietary calcium is not recommended because of the importance of calcium in building strong bones.

- Avoid calcium and vitamin D supplements.

- Eat an increased amount of potassium-rich foods, available in most fresh fruits and vegetables.

- If urine calcium levels are not decreased after three to six months of dietary changes, a medication may be recommended.

Hyperoxaluria — Children who have high levels of oxalate in the urine are advised to increase fluids and avoid foods that contain large amounts of oxalate, including beet and turnip greens, rhubarb, strawberries, star fruit, sweet potatoes, wheat bran, tea, cocoa, pepper, chocolate, parsley, beets, spinach, dill, nuts, and citrus juices. In addition, vitamin C supplements are not recommended.

Hyperuricosuria — Children with increased levels of urate in the urine are advised to increase fluids and may be given a treatment to increase the pH of the urine (potassium citrate or potassium carbonate).

Cystinuria — Children with high levels of cystine in the urine are encouraged to increase fluid intake and may be given a medication that reduces the acidity (ie, increases the pH) of the urine (potassium citrate or potassium carbonate). To ensure that fluid intake is adequate and that the urine pH is alkaline (the opposite of acidic), a urine sample may be tested.

Hypocitraturia — Children who have a low level of citrate in the urine are usually given a treatment to increase citrate levels (potassium citrate or potassium bicarbonate).

Struvite — Struvite stones usually develop as a result of urinary tract infections. Efforts to prevent recurrent struvite stones include prevention of urinary tract infections.

Complementary and alternative therapies — there are no data on the efficacy and safety of complementary and alternate therapies in the treatment of kidney stones in children. Nevertheless, both herbal and acupuncture therapies have commanded widespread interest and use, especially in Asian countries.

Monitoring — Following the first episode of kidney stones, imaging tests may be recommended to monitor for the development of new stones, especially in children who have multiple risk factors. The most common test used for monitoring is ultrasound. The frequency of monitoring depends upon the type and number of stones during the first episode, and the presence and severity of any underlying metabolic abnormality.

Management of ureteral calculi

The likelihood of spontaneous passage of a ureteral stone is related to both stone size and location. Most stones ≤4 mm in diameter pass spontaneously. Stone diameter ≥5 mm is associated with a progressive decrease in the spontaneous passage rate, which is unlikely with stones ≥10 mm in diameter. Proximal ureteral stones are also less likely to pass spontaneously. The data supporting these conclusions are presented elsewhere.

Symptomatic ureteral stones that do not pass spontaneously generally require removal by some modality such as lithotripsy or endoscopic removal. Developments in shock-wave lithotripsy technologies, with electrohydraulic and laser lithotripsy, have improved intracorporeal stone fragmentation. Advances in endoscopic modalities, with the development of rigid, and later, semi-rigid and flexible fiberoptic ureteroscopes, has made the entire ureter and renal pelvis accessible for the treatment of ureteral and renal stones. Advances in the fiberoptic lens systems enabled manufacture of smaller ureteroscopes that can traverse the ureter without prior dilation. The use of a ureteral access sheath has greatly simplified passage of the ureteroscope, thereby facilitating ureteroscopic access to the mid and proximal ureter, as well as to the intrarenal collecting system.

Treatment varies based upon the location and size of the stone. Most proximal ureteral stones ≤10 mm in size are managed either by shock wave lithotripsy or ureteroscopy. Ureteroscopy is used by many clinicians as the first line of treatment for mid and distal ureteral

stones. In addition, ureteroscopic or percutaneous access is often necessary for the management of ureteral calculi that have failed shock wave lithotripsy. Laparoscopy offers a minimally invasive treatment option for the removal of large or severely impacted ureteral calculi.

The management of ureteral calculi by stone location within the ureter will be reviewed here. Further discussion regarding the techniques utilized to treat ureteral calculi, the diagnosis of nephrolithiasis, and the significance of residual stones after stone removal is presented separately.

"Options in the management of renal and ureteral stones in adults" and see "Diagnosis and acute management of suspected nephrolithiasis in adults", and see "Clinical significance of residual stone fragments following stone removal").

Proximal ureteral calculi — the options for the treatment of proximal ureteral calculi include the following:

- Various first and second generation lithotriptors, which utilize fluoroscopic and ultrasound imaging systems.
- Flexible ureteroscopy
- Percutaneous antegrade techniques
- Retroperitoneal laparoscopy

Uric acid nephrolithiasis

Uric acid stones are nonopaque on radiologic examination. The prevalence of uric acid stones among patients with gout prior to effective antihyperuricemic treatment was about 20 percent, several hundred-fold greater than that in the adult non-gouty population.

Uric acid stones account for only 5 to 10 percent of all urinary tract stones. However, they comprise 40 percent or more of stones in areas with hot, arid climates in which the tendency to a low urine volume and acid urine pH promote uric acid precipitation.

More than 80 percent of uric acid stones in patients with gout are composed entirely of uric acid. The remainder contains calcium oxalate or calcium phosphate surrounding a central nidus of uric acid. The prevalence of calcium oxalate stones among patients with gout is 10- to 30-fold that of individuals without gout. This may be due to increased urinary calcium excretion and decreased citrate excretion. "Risk factors for calcium stones in adults".

The general approach to the patient with nephrolithiasis and other management issues related to hyperuricemia and gout are discussed separately.

"Evaluation of the adult patient with established nephrolithiasis and treatment if stone composition is unknown" and see "Clinical manifestations and diagnosis of gout" and see "Asymptomatic hyperuricemia").

RISK FACTORS — Uric acid nephrolithiasis primarily occurs in patients with no obvious abnormality in uric acid metabolism. However, upon closer examination, many possess a combination of findings that together favor stone formation. These include relatively high serum uric acid levels, comparatively low urinary pH and low fractional excretion of urate [4-6]. These abnormalities are similar to those seen in most patients with primary gout (underexcretors). (See "Asymptomatic hyperuricemia").

Clinical significance of residual stone fragments following stone removal

INTRODUCTION — Before the advent of shock wave lithotripsy and percutaneous nephrostolithotomy, patients underwent open surgical procedures for stone removal. A successful open surgical procedure was defined as complete removal of all stones without leaving any residual stone fragments. Patients with residual calculi were considered a treatment failure.

However, the introduction of less invasive procedures for the management of nephrolithiasis has resulted in a change in treatment goals. With these modalities, minimal emphasis is often placed on the presence of residual stone material postprocedure. Instead, success, as currently defined by some investigators, is determined by fragmentation rates and the size of remaining stone fragments. As an example, small stone fragments, such as those less than 5 mm in size, are considered by some clinicians to be "clinically insignificant."

Several studies, however, have noted a dramatic increase in stone formation with the presence of residual calculi following shock wave lithotripsy (SWL) or percutaneous stone removal [1-4]. As a result, it is unclear whether the changed criteria for successful "stone-free" surgery are correct, since residual fragments may act as a nidus for further stone formation.

The clinical significance of residual fragments following stone removal will be reviewed here. Detailed discussions of the methods and indications for stone removal are presented separately. (See "Options in the management of renal and ureteral stones in adults").

RESIDUAL FRAGMENTS FOLLOWING STONE REMOVAL — A high incidence of stone formation has been found among patients with residual calculi after SWL or other treatment modalities [1-6]. Based upon this observation, various algorithms and neural networks have been created to help predict the incidence of residual stones following lithotripsy treatment [7,8].

Cystine stones

INTRODUCTION — Cystinuria is a rare, autosomal recessive cause of kidney stones. Cystine stones are found in 1 to 2 percent of stone formers, although they represent a higher percentage of stones in children.

Patients with this disorder have an impairment in renal and intestinal cystine transport, with decreased proximal tubular reabsorption of filtered cystine resulting in increased cystine excretion [1-4]. The cystine transporter also promotes the reabsorption of the other dibasic amino acids, ornithine, arginine, and lysine. These compounds, however, are relatively soluble and an increase in their excretion does not lead to stone formation.

Cystinuria is a different disorder from cystinosis, which is characterized by intracellular cystine accumulation leading to the Fanconi syndrome and progressive renal failure. (See "Cystinosis").

CYSTINURIA PHENOTYPES — The following phenotypic scheme relating to cystinuria subtypes was developed prior to the isolation and clinical characterization of the genetic defects discussed in the next section. As will be reviewed, an absolute correlation between this system and known specific genetic defects does not exist, suggesting that another and perhaps simpler classification system should be adopted [5,6].

Multiple forms of cystinuria are classically identified; each subtype is characterized by the amounts of cystine excreted by the parents (who are almost always asymptomatic heterozygotes, but could be homozygotes) of the afflicted individual [7]:

- Patients with type I/I cystinuria have parents who both excrete a normal amount of cystine (0 to 100 µmol/g creatinine). If approximately 1.2 g of creatinine is excreted per day, then 100 µmol/g creatinine is equivalent to the excretion of 27

mg of cystine/day. In this case, each parent is an obligate heterozygote of type I/N (ie, I/Normal).

- Patients with type II/II have parents who both excrete large amounts of cystine (990 to 1740 µmol/g creatinine). Given this high amount of excretion, these parents, who are both type II/N, are the only obligate heterozygotes at risk for stone formation.

- Patients with type III/III have parents who both excrete intermediate amounts (100 to 660 µmol/g creatinine). These parents are therefore type III/N.

- Those with combination forms or compound heterozygotes, such as type I/III, have parents who excrete different amounts of cystine.

Management of struvite or staghorn calculi

INTRODUCTION — Staghorn calculi refer to branched stones that fill all or part of the renal pelvis and branch into several or all of the calices. They are most often composed of struvite (magnesium ammonium phosphate) and/or calcium carbonate apatite. Cystine stones, although much less common, may also develop into staghorn calculi [1]. (See "Cystine stones").

These stones are often referred to as 'infection stones' since they are strongly associated with urinary tract infections with urea splitting organisms. A branched pattern of stone growth may also occur with cystine and uric acid stones, but is rare with calcium oxalate or phosphate stones.

Struvite and/or calcium carbonate apatite stones can grow rapidly over a period of weeks to months into a staghorn or branched calculus that involves the entire renal pelvis and calyces, and if left untreated, can lead to deterioration of kidney function and end-stage renal disease [2]. In addition, since the stones often remain infected, there is a risk of developing sepsis [3]. Thus, most patients require definitive surgical treatment.

There are several alternative surgical treatments for staghorn calculi. The American Urological Association Nephrolithiasis Guidelines Panel reviewed the existing literature to determine the optimal application of the different modalities of treatment [3,4]. This topic review is largely based on this Panel's recommendations for the management of staghorn calculi. Reviews of the pathogenesis and clinical manifestations of struvite stones, and of the management of renal and ureteral calculi in general, are presented separately. (See "Pathogenesis and clinical manifestations of struvite stones", and see "Options in the management of renal and ureteral stones in adults").

Limitations of the data — There are limitations that must be considered when interpreting and adopting guidelines for the optimal treatment of staghorn calculi [4]:

- Data from prospective controlled studies comparing treatment options are very limited.

- There is no uniform system of categorizing staghorn calculi, no standard method of describing the collecting system, and no widely accepted system of reporting the size of staghorn calculi.

- The indications for hospitalization may vary in different countries.

Pathogenesis and clinical manifestations of struvite stones

INTRODUCTION — Struvite stones may grow rapidly over a period of weeks to months and, if not adequately treated, can develop into a staghorn or branched calculus that fills the entire intra-renal collecting system. A review of the pathogenesis and clinical manifestations of struvite stones will be presented here. The management of these stones is discussed separately.).(See "Management of struvite or staghorn calculi"

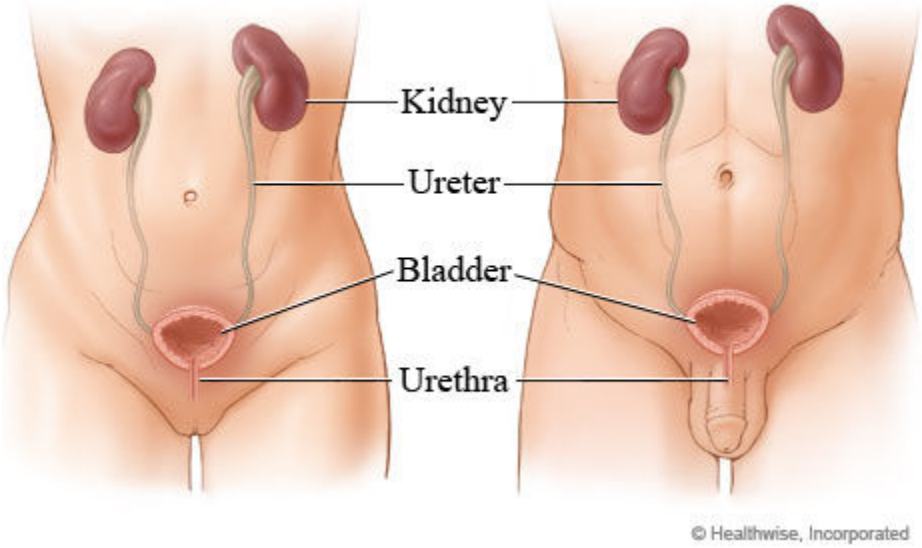
PATHOGENESIS — Struvite stones may be composed of magnesium ammonium phosphate (struvite), calcium carbonate-apatite, or a combination of both components [1]. Normal urine is undersaturated with ammonium phosphate and struvite stone formation occurs only when ammonia production is increased and the urine pH is elevated to decrease the solubility of phosphate. Both of these requirements may be met when urinary tract infection occurs with a urease-producing organism, such as Proteus or Klebsiella. Urease breaks down urinary urea into ammonia plus carbon dioxide:

$$\text{Urea} \longrightarrow 2NH_3 + CO_2$$

The ammonia produced by this reaction then combines with water:

$$NH_3 + H_2O \longrightarrow NH_4^+ + OH^-$$

Urinary tract



The kidneys and bladder work together to make urine and remove it from your body. The kidneys filter waste products and water from the blood to form urine. The urine moves from the kidneys through tubes called ureters to the bladder, which stores the urine until it is full. From the bladder, urine leaves the body through another thin tube, the urethra. After the bladder starts to empty, it normally empties all of the urine.

The list of signs and symptoms mentioned in various sources for Kidney stones includes the 18 symptoms listed below:

- No early symptoms - early stages have no symptoms
- Severe abdominal pain
- Kidney pain - sharp pain usually on the back and at the side
    - Severe back pain
    - Side pain
- Nausea
- Vomiting
- Groin pain
- Hematuria
- Kidney infection symptoms - very serious symptoms:
    - Fever
    - Chills
    - Vomiting
    - Blood in urine
    - Smelly urine
    - Cloudy urine
    - Burning when urinating
    - Urinary urgency

Kidney Stones - Treatment Overview

Your first diagnosis of kidney stones often occurs when you see your doctor or go to an emergency room because you are in great pain. Your doctor may suggest that you wait for the stone to pass and take pain medicine or have a procedure to remove the stone.

Most small stones [less than 5mm] move out of the body (pass) without the need for any treatment other than drinking extra fluids and taking pain medicine.[1]

- The smaller a stone is, the more likely it is to pass on its own. About 9 out of every 10 stones smaller than 5mm and about 5 out of every 10 stones 5mm to 10mm pass on their own.[1] Only 1 or 2 out of every 10 kidney stones need more than home treatment.[1]
- The average time a stone takes to pass ranges between 1 and 3 weeks,[1] and two-thirds of stones that pass on their own pass within 4 weeks of when the symptoms appeared.[2]

Not all kidney stones are diagnosed because of immediate symptoms. Your stone may not be causing you pain, and your doctor may find it during a routine exam or an exam for another condition or disease. In this case, you have the same treatment options as noted below.

Treatment for your first stone

If your doctor thinks the stone can pass on its own, and you feel you can deal with the pain, he or she may suggest home treatment, including:

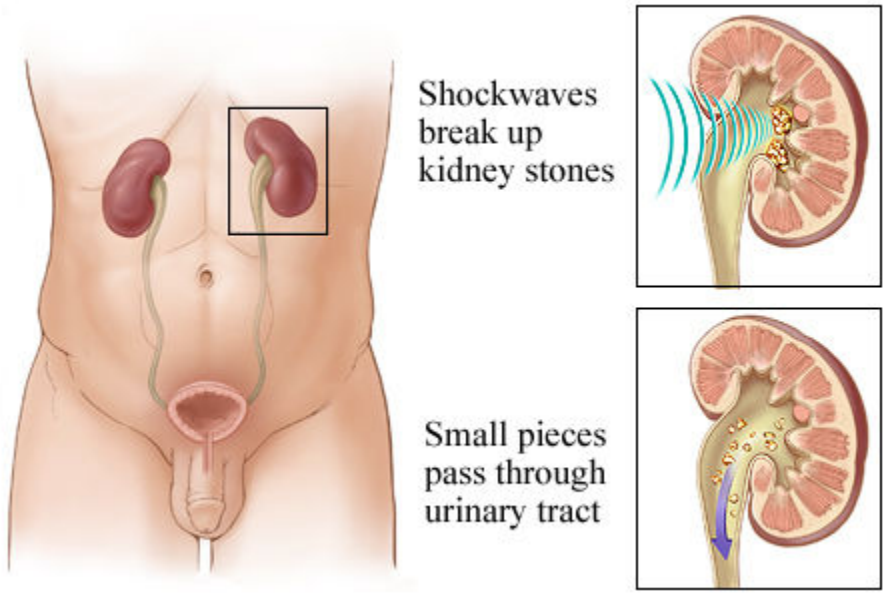
- Drinking more fluids. You need to drink enough water to keep your urine clear, about 8 to 10 glasses a day. Try to drink 2 glasses of water every 2 hours while you are awake. If you have kidney, heart, or liver disease and are on fluid restrictions, talk with your doctor before increasing your fluid intake.
- Not drinking grapefruit juice. Drinking grapefruit juice may increase your risk for developing kidney stones.
- Using pain medicine. Nonprescription medicine, such as nonsteroidal anti-inflammatories (NSAIDs), may relieve your pain. Your doctor can prescribe stronger pain medicine if needed.

Your doctor may prescribe medicine to help your body pass the stone. Calcium channel blockers and alpha-blockers have been shown to help kidney stones pass more quickly with very few side effects.[11] Ask your doctor if one of these medicines can help you.

If your pain is too severe, if the stones are blocking the urinary tract  , or if you also have an infection, your doctor will probably suggest medical or surgical treatment. Your options are:

- Extracorporeal shock wave lithotripsy (ESWL). ESWL uses shock waves that pass easily through the body but are strong enough to break up a kidney stone. This is the most commonly used medical treatment for kidney stones. See a picture of ESWL.
- Percutaneous nephrolithotomy or nephrolithotripsy. The surgeon puts a narrow telescope into the kidney through a cut in your back. He or she then removes the stone (lithotomy) or breaks it up and removes it (lithotripsy). This procedure may be used if ESWL does not work or if you have a very large stone. See a picture of nephrolithotomy.
- Ureteroscopy. The surgeon passes a very thin telescope tube (ureteroscope) up the urinary tract to the stone's location, where he or she uses instruments to remove the stone or break it up for easier removal. Occasionally, you may need a small hollow tube (ureteral stent) placed in the ureter for a short time to keep it open and drain urine and any stone pieces. Ureteroscopy is often used for stones that have moved from the kidney to the ureter. See a picture of ureteroscopy.
- Open surgery. The surgeon makes a cut in the side or the belly to reach the kidneys and remove the stone. This treatment is rarely used.

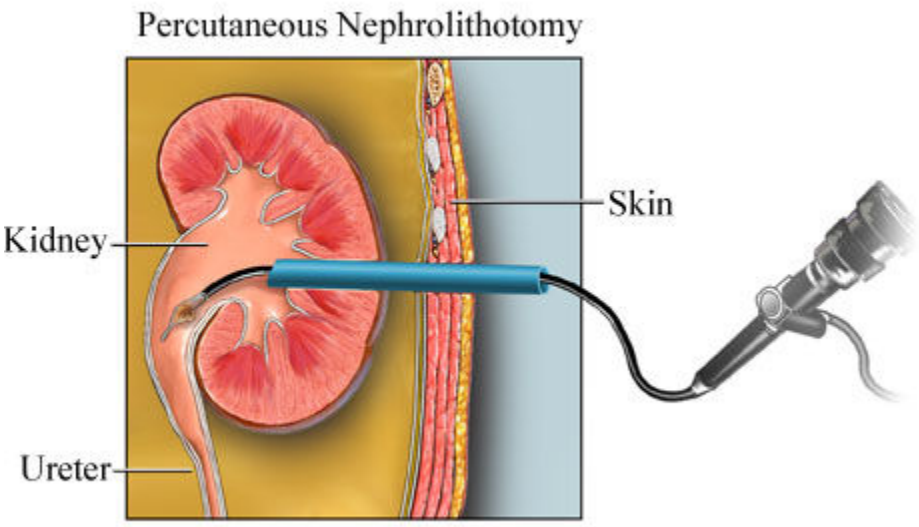
Extracorporeal shock wave lithotripsy (ESWL)



Extracorporeal shock wave lithotripsy (ESWL) uses shock waves to break a kidney stone into small pieces that can more easily travel through the urinary tract and pass from the body.

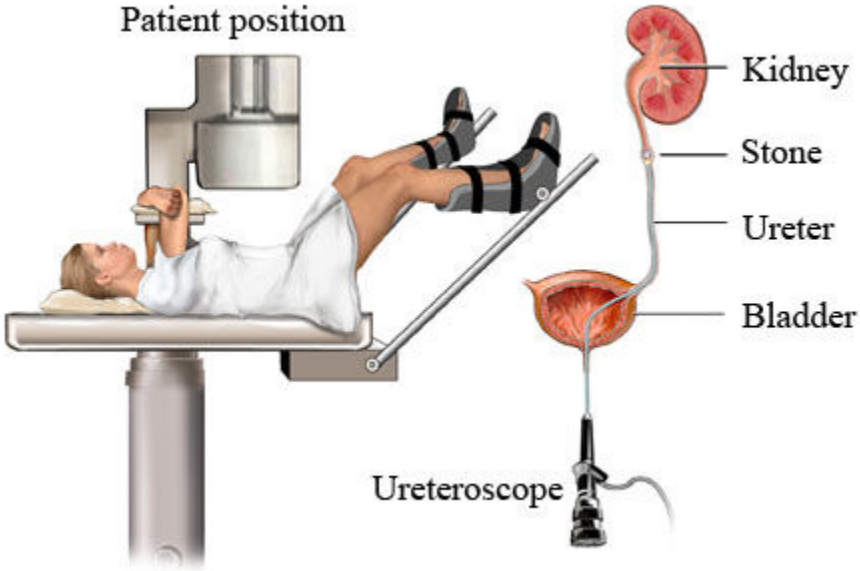
You lie on a water-filled cushion. X-rays or ultrasound tests are used to precisely locate the stone. High-energy sound waves pass through your body without injuring it and break the stone into small pieces.

Percutaneous nephrolithotomy



Percutaneous nephrolithotomy or nephrolithotripsy uses a small incision in the person's back to remove kidney stones. The surgeon puts a hollow tube into the kidney and a probe through the tube. In nephrolithotomy, the surgeon removes the stone through the tube. In nephrolithotripsy, he or she breaks the stone up and then removes the fragments of the stone through the tube.

Ureteroscopy



In a ureteroscopy, the surgeon passes a thin viewing instrument (ureteroscope) through the tube from the bladder out of the body (urethra) into the bladder, and then into the ureter to the location of the kidney stone. No incisions are made in the body.

Your surgeon removes the kidney stone using forceps or an instrument with a small "basket." Smaller stones can be removed all in one piece. Larger stones may need to be broken up before the surgeon can remove them.

After you have had a kidney stone, you are more likely to have one again. Almost half of all people who have a stone will have more stones within 5 years unless they take preventive measures.[3] You may be able to prevent getting more kidney stones by drinking more fluids and making changes in your diet. If you have risk factors for having more stones, such as a family history of stones, your doctor may suggest medicines that help prevent stones from forming.

What To Think About

Your doctor may ask you to collect your urine for 24 hours after you pass a stone so your urine can be tested to find out the type and cause of the stone. Knowing the type of stone can help determine what you can do to avoid having another.

In rare cases, a person forms kidney stones because the parathyroid glands produce too much of a hormone, which leads to higher calcium levels and possibly calcium kidney stones. To help prevent stones from coming back, your doctor may suggest surgery to remove a parathyroid gland or glands (parathyroidectomy).

You may require more treatment for your kidney stones if you have continuing problems and:

- A lot of urinary tract infections.
- Decreased kidney function.
- A single kidney.
- An impaired immune system.
- Have had a kidney transplant.

- **Other conditions** associated with an increased risk of kidney stones include hyperparathyroidism, kidney diseases such as renal tubular acidosis, and some inherited metabolic conditions including cystinuria and hyperoxaluria. Chronic diseases such as diabetes and high blood pressure (hypertension) are also associated with an increased risk of developing kidney stones.

What is the treatment for kidney stones?

Most kidney stones eventually pass through the urinary tract on their own within 48 hours, with ample fluid intake. Pain medications can be prescribed for symptom relief. There are several factors which influence the ability to pass a stone. These include the

size of the person, prior stone passage, prostate enlargement, pregnancy, and the size of the stone. A 4 mm stone has an 80% chance of passage while a 5 mm stone has a 20% chance. Stones larger than 9-10 mm rarely pass on their own and usually require treatment.

Some medications have been used to increase the passage rates of kidney stones. These include calcium channel blockers such as nifedipine and alpha blockers such as tamsulosin. These drugs may be prescribed some people who have stones that do not rapidly pass through the urinary tract.

For kidney stones which do not pass on their own, a procedure called lithotripsy is often used. In this procedure, shock waves are used to break up a large stone into smaller pieces that can then pass through the urinary system.

Surgical techniques have also been developed to remove kidney stones. This may be done through a small incision in the skin (percutaneous nephrolithotomy) or through an instrument known as an ureteroscope passed through the urethra and bladder up into the ureter.

How can kidney stones be prevented?

Rather than having to undergo treatment, it is best to avoid kidney stones in the first place. It can be especially helpful to drink more water. (The National Institutes of Health recommend drinking up to 12 full glasses of water a day, if you've already had a kidney stone.) Water helps to flush away the substances that form stones in the kidneys.

Depending on the cause of the kidney stones and an individual's medical history, dietary changes or medications are sometimes recommended to decrease the likelihood of developing further kidney stones. It is particularly helpful, if one has passed a stone, to have it analyzed in a laboratory to determine the precise type of stone so specific prevention measures can be considered.

Kidney stones

Published by Bupa's health information team, November 2006.

This factsheet is for people who develop kidney stones and those who want to know more about them.

Kidney stones are hard, stone-like masses that can form in one or both kidneys. They are fairly common, occurring in about 12 in every 100 men and 4 in every 100 women in the UK at some point in their life.

Kidney stones are usually painless when in the kidney but can cause severe pain as they travel from the kidneys to the bladder. An attack of this pain is called renal or uteric colic.

What are kidney stones?

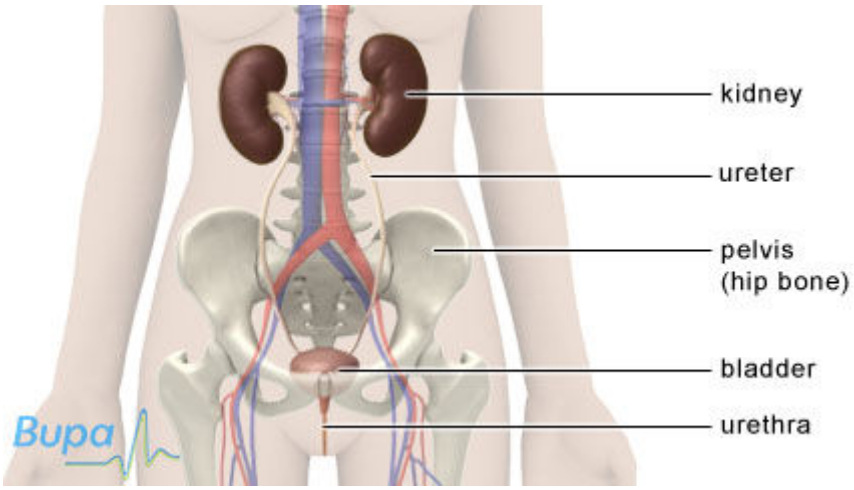
Most people have two kidneys (see illustration), which "clean" the blood. They filter out water and waste products, making urine.

Kidney stones are small, solid masses that form when salts or minerals normally found in urine become solid crystals (crystallise) inside the kidney. In most cases, the crystals are too tiny to be noticed, and pass harmlessly out of your body. However, they can build up inside your kidney and form much larger stones.

If a stone becomes large enough, it may begin to move out of your kidney and progress through the ureters - the tubes that carry urine from the kidney to your bladder.

If it gets stuck in the ureter, this can cause an infection which can lead to permanent kidney damage.

Depending on where they are located, kidney stones are also known as renal calculi, urinary calculi, urinary tract stone disease, nephrolithiasis, urolithiasis and ureterolithiasis.



The position of the kidneys and surrounding structures

What are the symptoms?

Many kidney stones don't move and are too small to cause any symptoms. However, if a kidney stone causes a blockage, or moves into the ureter, it may cause some of the following symptoms:

- severe pain or aching in the back on one or both sides
- sudden spasms of excruciating pain (renal or uteric colic) - this usually starts in the back below the ribs, before radiating around the abdomen, and sometimes to the groin and genitalia

- bloody, cloudy or smelly urine
- feeling or being sick
- a frequent urge to urinate, or a burning sensation during urination
- fever and chills

These can also be symptoms of a urinary tract infection, or cystitis, which is much more common than kidney stones in young women. If you have one or more of these symptoms you should seek medical advice.

Kidney stones are usually passed out of the body within 48 hours, but attacks can sometimes last for over 30 days.

What causes kidney stones?

Kidney Stones Causes

There is no consensus as to why kidney stones form.

- **Heredity:** Some people are more susceptible to forming kidney stones, and heredity certainly plays a role. The majority of kidney stones are made of calcium, and hypercalciuria (high levels of calcium in the urine), is a risk factor. The predisposition to high levels of calcium in the urine may be passed on from generation to generation. Some rare hereditary diseases also predispose some people to form kidney stones. Examples include people with renal tubular acidosis and people with problems metabolizing a variety of chemicals including cystine (an amino acid), oxalate, (a type of salt), and uric acid (as in gout).

- **Geographical location:** There is also a geographic predisposition in some people who form kidney stones. There are regional "stone belts," with people living in the Southern United States, having an increased risk. This is likely because of the hot climate, since these people can get dehydrated, and their urine becomes more concentrated, allowing chemicals to come in closer contact and begin forming the nidus of a stone.

- **Diet:** Diet may or may not be an issue. If a person is susceptible to forming stones, then foods high in calcium may increase the risk, however if a person isn't susceptible to forming stones, nothing in the diet will change that risk.

- **OTC products:** People taking diuretics (or "water pills") and those who consume excess calcium-containing antacids can increase the amount of calcium in their urine and increase their risk of forming stones. Patients with HIV who take the medication indinavir (Crixivan) can form indinavir stones.

In most people the underlying cause isn't known. Some people with kidney stones have lower levels of citrate in their urine, which usually stops the stones forming.

Different kinds of kidney stones form from different salts in the urine.

Calcium stones are the most common type of kidney stone. They are either spiky or large and smooth, and are made up of calcium oxalate or calcium phosphate.

Calcium stones are more common in people who have excess levels of vitamin D or who have an overactive parathyroid gland. People who have medical conditions such as cancer, some kidney diseases, or a disease called sarcoidosis are also more likely to develop calcium stones.

Uric acid stones are smooth, brown and soft. Excess amounts of uric acid can be caused by eating a lot of meat. Conditions such as gout and treatments such as chemotherapy can also increase the risk of getting uric acid stones.

Struvite stones (infection stones) are usually large and have a horn-like shape. They develop when there is too much ammonia in the urine. This can happen if you have a urinary tract infection (UTI), because the bacteria that cause these infections can generate ammonia. This kind of kidney stone is most often found in women.

Cystine stones are yellow and crystalline. They develop if you have high levels of cystine in your urine, which happens if you have a hereditary disorder called cystinuria. Only one in a hundred kidney stones are caused by this condition. Cystine stones tend to develop earlier in life than other kidney stones, usually between the ages of 10 and 30 years.

Who gets kidney stones?

Men are more prone than women, and around half of all people who have previously had a kidney stone will develop another one within five years.

Other risk factors include:

- a family history of kidney stones
- being aged between 20 and 40
- taking certain medicines such as diuretics (water tablets), antacids and thyroid medications
- having only one kidney, or an abnormally shaped kidney
- eating a diet high in protein
- being regularly dehydrated
- having very poor mobility (eg, being confined to bed)
- having a disease of the small intestine or a small intestinal bypass

How are kidney stones diagnosed?

Doctors can usually diagnose kidney stones by asking about your symptoms and examining you. Further tests may be done to confirm the diagnosis and to reveal the size, location and type of stone. These include:

- blood tests - to identify excess amounts of certain chemicals related to the formation of stones
- urine analysis - to look for signs of infection
- taking an X-ray image - stones that contain calcium usually show up white on X-ray images
- an intravenous urogram (IVU) - this involves an injection of a special dye that shows up the whole urinary system on X-ray images, revealing stones that can't usually be seen
- ultrasound scan - this uses high frequency sound waves to produce an image of the internal organs
- non-contrast helical computerised tomography - this produces pictures from a series of X-ray images taken at different angles - it is sometimes used to diagnose kidney stones, and is thought to be the most accurate diagnostic test

How are kidney stones treated?

Treatment depends on the type and cause of the stone. Most stones can be treated without surgery. Drinking lots of water (two and a half to three litres per day) and staying physically active are often enough to move stones smaller than about five millimetres out of your body. You may be prescribed paracetamol or codeine to reduce the pain.

Your doctor may ask you to catch the kidney stone by passing your urine through filter paper or a tea strainer. The stone can then be analysed to find out what type it is to help guide your treatment.

However, if there is an infection, a blockage, or a risk of kidney damage, you will receive treatment to remove your stone. Infections can be treated with antibiotics. Stones that are stuck can be removed in several ways:

Extracorporeal shock wave lithotripsy (ESWL)

This is the most common method of dealing with kidney stones. The kidney stone is located using X-ray imaging or ultrasound scanning. While you are lying down, a machine called a lithotriptor sends targeted shock waves to break up the kidney stone into crystals small enough to be passed in your urine. Because it can be uncomfortable when the kidney stones break up, you will be given painkillers before the procedure is started.

Ureteroscopic stone removal

If a stone is lodged in the ureter, a narrow, flexible instrument called a cystoscope can be passed up through the urethra and bladder. The stone is captured and removed, or broken

up with a laser beam or shock waves generated by a device attached at the end of the cytoscope. This procedure is usually done under a general anaesthetic.

Percutaneous nephrolithotomy (PCNL)

Large stones can be surgically removed from the kidney. The surgeon makes a small cut in your back and uses a telescopic instrument called a nephroscope to pull the stone out or break it up with shock waves or a laser.

PCNL is performed under general anesthesia. This can temporarily affect your co-ordination and reasoning skills, so you should not drive, drink alcohol, operate machinery or sign legal documents for 48 hours afterwards. If you are in any doubt about driving, please contact your motor insurer so that you are aware of their recommendations, and always follow your doctor's advice.

Prevention

- While kidney stones and renal colic probably cannot be prevented, the risk of forming a stone can be minimized by avoiding dehydration. Keeping the urine dilute will not allow the chemical crystals to come out of solution and form the nidus of a stone. Making certain that the urine remains clear and not concentrated (yellow) will help minimize stone formation.

- Medication may be prescribed for certain types of stones, and compliance with taking the medication is a must to reduce the risk of future stone episodes

To help prevent any type of kidney stone you should drink more fluid. You should aim to drink at least three litres every 24 hours, or enough to make your urine clear rather than a yellow colour. Talk to your doctor for more advice on this.

It used to be thought that reducing the amount of calcium in your diet would lower the risk of developing calcium stones. However, research has shown that a diet containing normal or even increased amounts of calcium containing food (such as dairy products or green leafed vegetables) may be more helpful.

If you get calcium oxalate stones, cut down on foods that have high levels of oxalate - chocolate, tea, rhubarb, cooked spinach and asparagus.

If you get uric acid stones you should eat less meat, fish and poultry, and your doctor may prescribe medicine to help reduce the level of uric acid in your urine.

You should discuss dietary changes with your doctor as they are not appropriate for everyone.

If you get cystine stones, your doctor may prescribe medicines to reduce the chance of the stones forming.

If you develop struvite or "infection" stones your urine must be kept free of the bacteria that are causing the infection. This may mean taking long-term antibiotics.

Self-Care at Home

- Prevention is always the preferable way to treat kidney stones. Remaining well hydrated and keeping the urine dilute will help prevent kidney stones from forming.

- Those who have never passed a kidney stone may not appreciate the severity of the symptoms. There is little a person can do with debilitating pain and vomiting other than seek emergency care. If this is the first episode and no previous diagnosis has been established, it is important to be seen by a physician as well. For those who have a history of stones, then home therapy may be appropriate. Most kidney stones, given time, will pass on their own, and treatment is directed towards symptom control. The patient should be instructed to consume oral fluids. Ibuprofen can be used as an anti-inflammatory agent, and if further pain medication is needed, contacting the primary care provider may allow stronger narcotic pain medication to be prescribed.

- **Please note, if there is fever associated with the symptoms of a kidney stone, this becomes a more urgent problem, and medical care should be accessed immediately.**

- Pain control at home follows the lead of the hospital treatment. Over-the-counter (OTC) ibuprofen is used as an anti-inflammatory medication, and narcotic pain pills are provided. Anti-nausea medication may be prescribed either by mouth or by suppository. Tamsulosin (Flomax, a drug used to facilitate urination in men with enlargement of the prostate) may be used to help with the passage of stones.

- Because of their size or location, some stones may not be able to be passed without help. If the stone is high up in the ureter, near the kidney, and is large, then a urologist may need to consider using lithotripsy, or shock wave therapy, to break the stone up into fragments to allow the smaller parts to pass. Shock waves work by vibrating the urine surrounding the stone and causing the stone to break up. Stones that are lodged nearer the bladder do not have surrounding urine to allow this procedure to work and succeed.

- If the stone is not is a place where lithotripsy can work or if there is a need to relieve the obstruction emergently (an example would include an infection), the urologist may perform cystoscopy where a stent (a thin hollow tube) is passed through the urethra, past the bladder, and into the ureter to bypass the obstructing stone. This stent is left in place for a longer period of time. Occasionally, the urologist may be able to use instruments to grab the stone and remove it.

Complications

- Since most patients have two kidneys, a temporary obstruction of one is not of great significance. For those patients with only one kidney, an obstructing stone can be a true emergency, and the need to relieve the obstruction becomes greater. A kidney that remains completely obstructed for a prolonged period of time may stop working.

- Infection associated with an obstructing stone is another emergent situation. When urine is infected and cannot drain, it acts like an abscess and can spread the infection throughout the body (sepsis). Fever is a major sign of this complication, but urinalysis may show an infection and cause the urologist to act to place a stent or remove the stone.

Follow-up

- For the first-time kidney stone patient, there should be an attempt to catch the stone by straining the urine, so that it can be sent for analysis. The stone may be so tiny that it may not be recognized. While most stones are made of calcium oxalate, should that not be the case, knowing what type of stone is the culprit may be helpful in preventing further episodes. For those whose stone disease is recurrent and the kind of stone is known, this instruction is omitted.

- Drinking plenty of water will help push the stone down the ureter to the bladder and hasten its elimination.

- A follow-up visit with a urologist will be arranged one to two weeks after the initial visit, allowing the stone to pass on its own.

- Patients should call their physician or return to the emergency department if the pain medication is not working to control the pain, if there is persistent vomiting, or if a fever occurs.

Alternative Treatment

Naturopathic Treatment

From a naturopathic perspective, kidney stones that do not occur as a result of a genetic or metabolic disorder are considered to be a diet-related condition. Proper nutrition can support healthy kidney function and may discourage stone formation, and natural therapies may help ease the pain and spasm that accompanies stone passage. Kidney stone treatment should be undertaken only after a physician has made a definitive diagnosis.

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Nutrition

The following nutritional recommendations may help to prevent stone formation or recurrence:

- **Eat** a whole foods diet that contains leafy green vegetables, fruits, vegetables, whole grains, legumes, and fish and poultry in small portions. Include foods that have a high ratio of magnesium to calcium such as brown rice, bananas, oats, barley, and soy, and that are high in fiber such as oat bran, psyllium seed husk, and flaxseed meal.
- **Drink** a minimum of 50% of body weight in ounces of water daily (e.g., a 150 lb person would drink 75 oz of water). Proper hydration helps prevent the urine from becoming concentrated with crystals, which can lead to stone formation; and reduces the risk for urinary tract infections, which may lessen the risk for struvite stones. Urine color can indicate the level of concentration: dark or bright yellow urine indicates highly concentrated urine; pale or colorless urine indicates dilute urine.
- **Avoid** sugar (check ingredients for hidden sources of sugar), alcohol, antacids, excessive protein, dairy products (especially milk), salt, carbonated beverages, caffeine, and refined white flour products such as pasta, white bread, and baked goods.

Supplements

- **Magnesium citrate**–Take 500 mg daily. Low magnesium intake has been linked to stone formation. Magnesium supplementation may decrease the size of an existing stone and prevent further formations. Citrate supplementation may prevent further stone formation.
- **Vitamin B-6**–Take 25 mg daily. A B-6 deficiency increases urinary oxalate, which may lead to kidney stones.

Herbal Medicine

Herbal medicines usually do not have side effects when used appropriately and at suggested doses. Occasionally, an herb at the prescribed dose causes stomach upset or headache. This may reflect the purity of the preparation or added ingredients, such as synthetic binders or fillers. For this reason, it is recommended that only high-quality products be used. As with all medications, overdosing can lead to serious illness and death.

These herbs are sometimes used to ease the discomfort associated with stone passage:

- **Bearberry (Arctostaphylos uva-ursi)**–Acts as a diuretic and antiseptic for the urinary tract.
- **Cleavers (Galium aparine)**–Has a history of use in treatment of congestive kidney disorders, stones, and urinary infections.
- **Corn silk (Zea mays)**–A soothing demulcent with mild diuretic properties.
- **Crampbark (Viburnum opulus)**–Relaxes smooth muscle and is an antispasmodic.
- **Gravel root (Eupatorium purpureum)**–Named for its traditional use as a treatment for stones and gravel of the kidneys.
- **Kava kava (Piper methysticum)**–Has antianxiety and sedative qualities.
- **Khella (Ammi visnagi)**–Has a long tradition in the treatment of kidney stones. Scientific research has demonstrated that the herb may work as a calcium channel blocker-type antispasmodic, which targets and relaxes ureter tissue. This may allow easier passage of small stones.
- **Seven barks (Hydrangea aborescens)**–Has a sedative effect on the urinary system; used in the treatment of kidney stones.
- **Stone root (Collinsonia canadensis)**–Strong diuretic with a history of use in acute and preventative treatment of kidney stones.

Homeopathy

Homeopathic medicines may be utilized by naturopathic physicians to treat the pain and spasm associated with kidney stones. When treating the passage of a kidney stone with homeopathy, it is important to remember that the size of the stone must be small enough to pass without surgical intervention and that administration of the homeopathic medicine usually changes the clinical picture, which will then require a different remedy. Other therapies, such as herbal medicines, hot packs, and supplements, are sometimes used with homeopathy.

The following homeopathic remedies have been utilized by naturopathic physicians in treating a kidney stone:

- **Berberis vulgaris**–Indicated for sharp, stitching pains that radiate to the groin area and right-sided kidney stones.
- **Cantharis**–Indicated for urine that burns and is passed drop by drop.
- **Colocynthis**–Indicated for pain over the whole abdomen while urinating.
- **Ocimum canum**–Indicated for pain accompanied by nausea and vomiting.
- **Pennyroyal**–Indicated for frequent urination and left-sided ureter spasm or stone.

The standard dosage for acute symptom relief is 3 pellets of 30C every 4 hours until symptoms resolve. Lower potencies, such as 6X, 6C, 30X, may be given every 2 to 4 hours. Symptoms may improve shortly after the second dose. If there is no improvement after 3 doses, a different remedy is given. Note: Most homeopathic remedies are delivered in a pellet that has a lactose (milk sugar) base. Homeopathic liquid may be a better choice for those who are lactose intolerant.

Hydrotherapy

- **Castor oil pack**–Castor oil has antiinflammatory properties and may be used to relieve painful cramping or spasms.
- **Hot pack**–Placed over the affected area, hot packs can relax muscles that are tense from pain and spasm, allowing for easier passage of the stone. Use caution in the elderly and diabetics, as they are less sensitive to heat and may be burned.
- **Hot vinegar pack**–Indicated for severe pain: use a 50:50 vinegar-water solution and place over affected area.

Defects in the general metabolism

The formation of stones in the kidneys is the result of defects in the general metabolism.They usually occur when the urine becomes highly concentrated due to heavy perspiration or insufficient intake of fluids. They are aggravated by a sedentary life-style.

wrong diet, excess intake of acid-forming foods, white flour and sugar products

The other causes are a wrong diet, excess intake of acid-forming foods, white flour and sugar products, meat, tea,coffee, condiments and spices, rich foods, and overeating.

Lack of vitamin A, excessive intake of vitamin D

Lack of vitamin A and an excessive intake of vitamin D may also lead to formation of stones.

Home remedy for kidney stones

Kidney Stones treatment using Kidney Beans

Kidney beans, also known as dried French beans or Rajmah, are regarded as a very effective home remedy for kidney problems, including kidney stones. The method prescribed to prepare the medicine is to remove the beans from inside the pods, then slice the pods and put about sixty grams in four litre of hot water, boiling them slowly for six hours. This liquid should be strained through fine muslin and then allowed to cool for about eight hours. Thereafter the fluid should be poured through another piece of muslin without stirring.A glass of this decoction should be given to the patient every two hours throughout the day for one day and, thereafter, it may be taken several times a week. This decoction would not work if it was more than twenty-four hours old. The pods could be kept for longer periods but once they were boiled, the therapeutic factor would disappear after one day.

Kidney Stones treatment using Basil

Basil has a strengthening effect on the kidneys.In case of kidney stones, one teaspoon each of basil juice and honey should be taken daily for six months. It has been found that stones can be expelled from the urinary tract by this treatment.

Kidney Stones treatment using Celery

Celery is a valuable food for those who are prone to getting stones in the kidneys or gall-bladder. Its regular intake prevents future stone formation.

Kidney Stones treatment using Apple

Apples are useful in kidney stones. In countries where the natural unsweetened cider is a common beverage, cases of stones or calculus are practically absent. The ripe fresh fruit is, however, more valuable.

Kidney Stones treatment using Grapes

Grapes have an exceptional diuretic value on account of their high contents of water and potassium salt. The value of this fruit in kidney troubles is enhanced by its low albumin and sodium chloride content. It is an excellent cure for kidney stones.

Kidney Stones treatment using Pomegranate

The seeds of both sour and sweet pomegranates are useful medicine for kidney stones. A tablespoon of the seeds, ground into a fine paste, can be given along with a cup of horse gram (kulthi) soup to dissolve gravel in kidneys. Two tablespoons of horse gram should be used for preparing the cup of soup.

Kidney Stones treatment using Watermelon

Watermelon contains the highest concentration of water amongst all fruits. It is also rich in potassium salts. It is one of the safest and best diuretics which can be used with beneficial result in kidney stones.

Kidney Stones treatment using Vitamin B 6

Research has shown the remarkable therapeutic success of vitamin B6 or pyridoxine in the treatment of kidney Stones. A daily therapeutic does of 100 to 150 mg of vitamin B6, preferably, combined with other B complex vitamins, should be continued for several months for getting a permanent cure.

Diet for kidney stones

Avoid foods like alcoholic beverages; condiments and pickles; certain vegetables like cucumber, radish.

A patient with kidney stones should avoid foods, which irritate the kidneys, to control acidity or alkalinity of the urine. He should also ensure adequate intake of fluids to prevent the urine from becoming concentrated. The foods considered irritants to the kidneys are alcoholic beverages; condiments and pickles; certain vegetables like cucumber, radish, tomato, spinach, rhubarb; those with a strong aroma such as asparagus, onion, beans, cabbage, and cauliflower; meat and gravies; and carbonated waters.

Intake of calcium and phosphates should be restricted

For controlling the formation of calcium phosphate stones, the intake of calcium and phosphates should be restricted. Foods which should be avoided are wholewheat flour, Chickpea, peas, soyabean, beet, spinach, cauliflower, turnips, carrots, almonds, and coconuts. When stones are composed of calcium, magnesium phosphates, and carbonates, the diet should be so regulated as to maintain an acidic urine. On the other hand, the urine should be kept alkaline if oxalate and uric acid stones are being formed. In the latter case, fruits and vegetables should be liberally used, and acid-forming foods should be kept to the minimum necessary for satisfactory nutrition. In case of uric stones, foods with a high purine content such as sweet breads, liver, and kidney should be avoided.

Take a low-protein diet and have liberal intake of water

The patient should take a low-protein diet, restricting protein to one gram per kilogram of food. A liberal intake of fluid upto three litres or more daily is essential to prevent the precipitation of salt into the form of stones.

Mayo Clinic

Mayo Clinic is a leader in the treatment and prevention of kidney stones. Mayo possesses the state-of-the-art equipment necessary for the diagnosis and treatment of all types of kidney stones. Our experienced physicians are leaders in refining new technology and procedures. Mayo Clinic doctors performed some of the first minimally invasive kidney stone removals in the United States, and remain committed to progressive treatments and prevention plans.

Diagnosis

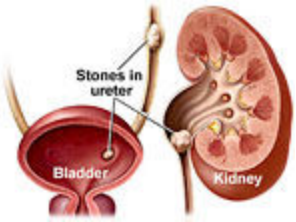
If a doctor suspects kidney stones, diagnosis is usually confirmed via a spiral CT scan, an ultrasound or a special X-ray test. Read more about kidney stone diagnosis.

Treatment Options

Mayo Clinic specialists evaluate each patient's need for kidney stone treatment, and recommend measures to prevent additional stones from forming. Watchful waiting is the most common treatment, as most kidney stones are small enough to pass on their own. Mayo Clinic offers three minimally invasive ways of removing troublesome kidney stones. Read more about kidney stone treatmentoptions.

- Treatment in Arizona
- Treatment in Florida
- Treatment in Minnesota

About Kidney Stones



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The kidneys continuously create urine to remove excess water, minerals and waste products from the blood. Kidney stones are hard deposits of minerals that grow slowly over months or years. Some may pass from the kidneys and become lodged in the ureters or bladder. The most common kidney stones are formed from excess calcium or uric acid in the urine. People who tend to form stones can usually prevent them by following specific recommendations from their physicians.

Definition

Kidney stones (renal lithiasis) are small, hard deposits of mineral and acid salts on the inner surfaces of your kidneys. Normally, the substances that make up kidney stones are diluted in the urine. When urine is concentrated, though, minerals may crystallize, stick together and solidify. The result is a kidney stone. Most kidney stones contain calcium.

Passing kidney stones can be excruciating. The pain they cause typically starts in your side or back, just below your ribs, and radiates to your lower abdomen and groin.

Painful as they are, kidney stones usually cause no permanent damage. Medical intervention — apart from pain medication — is often unnecessary.

Still, it's important to find out what type of kidney stone you have and why it developed. Some of the underlying causes of kidney stones can be treated to prevent new stones

from forming. If no specific treatment exists, you may be able to stave off additional kidney stones simply by drinking more water and making a few dietary changes.

Symptoms

Until a kidney stone moves into the ureter — the tube connecting the kidney and bladder — you may not know you have it. At that point, these signs and symptoms may occur:

- Pain in the side and back, below the ribs
- Fluctuations in pain intensity, with periods of pain lasting 20 to 60 minutes
- Pain waves radiating from the side and back to the lower abdomen and groin
- Bloody, cloudy or foul-smelling urine
- Pain on urination
- Nausea and vomiting
- Persistent urge to urinate
- Fever and chills if an infection is present

Kidney stones that don't cause these symptoms may show up on X-rays when you seek medical care for other problems, such as blood in your urine or recurring urinary tract infections

Causes

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Kidney stones

Your kidneys are two bean-shaped organs, each about the size of your fist. They're located in back of your abdomen on each side of your spine, and their main function is to remove excess fluid, unneeded electrolytes and wastes from your blood in the form of urine. The ureters carry urine from your kidneys to your bladder, where it's stored until you eliminate it from your body.

Kidney stones form when the components of urine — fluid and various minerals and acids — are out of balance. When this happens, your urine contains more crystal-forming substances, such as calcium and uric acid, than the available fluid can dilute. At the same time, your urine may be short of substances that keep crystals from sticking together and becoming stones. Kidney stones are also prone to develop in highly acidic or highly alkaline urine.

Problems in the way your system absorbs and eliminates calcium and other substances create the conditions for kidney stones to form. Sometimes, the underlying cause is an inherited metabolic disorder or kidney disease. Gout promotes specific types of kidney stones, as does inflammatory bowel disease. So do some drugs, including furosemide (Lasix), used in treating heart failure and high blood pressure; topiramate (Topamax), an anti-seizure drug; and indinavir (Crixivan), which is used to treat human immunodeficiency virus, the cause of AIDS.

It's common, however, for kidney stones to have no definite, single cause. A number of factors, often in combination, create the conditions in which susceptible people develop kidney stones.

Most kidney stones contain crystals of more than one type. Determining the type that makes up the bulk of the stone — usually a combination of calcium compounds — helps identify the underlying cause. The best preventive approach after your first kidney stone also depends partly on the stone's composition.

- **Calcium stones.** Roughly four out of five kidney stones are calcium stones, usually in the form of calcium oxalate. Oxalate is found in some fruits and vegetables, but the liver produces most of the body's oxalate supply. Dietary factors, high doses of vitamin D, intestinal bypass surgery and several different metabolic disorders can increase the concentration of calcium or oxalate in urine.
- **Struvite stones.** Found more often in women, struvite stones are almost always the result of urinary tract infections. Struvite stones may be large enough to fill most of a kidney's urine-collecting space, forming a characteristic stag's-horn shape.
- **Uric acid stones.** These stones are formed of uric acid, a byproduct of protein metabolism. You're more likely to develop uric acid stones if you eat a high-protein diet. Gout also leads to uric acid stones. Certain genetic factors and disorders of the blood-producing tissues also may predispose you to the condition.
- **Cystine stones.** These stones represent only a small percentage of kidney stones. They form in people with a hereditary disorder that causes the kidneys to excrete excessive amounts of certain amino acids (cystinuria).

Risk factors

These factors may increase your risk of developing kidney stones:

- **Lack of fluids.** If you don't drink enough fluids, especially water, your urine is likely to have higher concentrations of substances that can form stones. That's also why you're more likely to form kidney stones if you live in a hot, dry climate or exercise strenuously without replacing lost fluids.
- **Family or personal history.** If someone in your family has kidney stones, you're more likely to develop stones too. And if you've already had one or more kidney stones, you're at increased risk of developing another.

- **Age and sex.** Most people who develop kidney stones are between 20 and 70 years of age. Men are more likely to develop kidney stones than are women.
- **Diet.** A high-protein, high-sodium and low-calcium diet may increase your risk of some types of kidney stones.
- **Limited activity.** You're more prone to develop kidney stones if you're bedridden or very sedentary for a long period of time. That's partly because limited activity can cause your bones to release more calcium.
- **Obesity.** High body mass index (BMI), increased waist size and weight gain have been linked to kidney stones in long-term studies of large populations. The relationship is strongest in women.
- **High blood pressure.** Having high blood pressure doubles your risk of forming kidney stones.
- **Gastric bypass surgery, inflammatory bowel disease or chronic diarrhea.** Changes in the digestive process affect your absorption of calcium and increase the levels of stone-forming substances in your urine.

Tests and diagnosis

Many kidney stones go unnoticed until they cause acute symptoms — specifically, the pain of a stone going through your ureter. Sometimes, however, kidney stones are discovered in the course of looking for the cause of chronic urinary tract infections or blood in the urine.

If your doctor suspects you have kidney stones, you're likely to have a blood analysis to look for excess calcium or uric acid and a 24-hour collection of urine to check whether you're excreting too many stone-forming minerals or too few inhibiting substances.

You may also have one or more of the following imaging tests:

- **Computerized tomography (CT) scan.** This imaging test has become the standard of care for evaluating acute kidney stones. It's rapidly performed, can identify stones regardless of composition and doesn't require the use of contrast dye.
- **Abdominal X-ray.** An abdominal X-ray can visualize most kidney stones and can help to judge changes in the size of a stone over time.
- **Ultrasound.** Instead of X-rays, this diagnostic technique combines high-frequency radio waves and computer processing to view your internal organs. It's safe, painless and noninvasive, but it may miss small stones, especially if they're located in a ureter or your bladder.
- **Intravenous pyelography (excretory urogram).** This study can be useful in determining the location of stones in the urinary system and can define the degree of blockage caused by a stone. A contrast dye is injected into a vein in your arm and a series of X-rays is taken as the dye moves through your kidneys, ureters and bladder. This study has largely been replaced by the CT scan but is still useful in limited circumstances.

If you're about to pass a stone, your doctor may ask you to urinate through a strainer so that the stone can be recovered and analyzed.

Complications

If a stone stays inside one of your kidneys, it usually doesn't cause a problem unless it becomes so large it blocks the flow of urine. This can cause pressure and pain, along with the risk of kidney damage, bleeding and infection. Smaller stones may partially block the thin tubes that connect each kidney to your bladder or the outlet from the bladder itself. These stones may cause ongoing urinary tract infections or kidney damage if left untreated.

Treatments and drugs

Treatment for kidney stones varies, depending on the type of stone and the cause. You may be able to move a stone through your urinary tract simply by drinking plenty of water — as much as 2 to 3 quarts (1.9 to 2.8 liters) a day — and by staying physically active.

Stones that can't be treated with more-conservative measures — either because they're too large to pass on their own or because they cause bleeding, kidney damage or ongoing urinary tract infections — may need professional treatment. Procedures include:

- **Extracorporeal shock wave lithotripsy (ESWL).** This is a commonly used procedure for treating kidney stones. It uses shock waves to break the stones into tiny pieces that are then passed in your urine. In some cases, you may be partially submerged in a tub of water during the procedure. In others, you may lie on a soft cushion. You'll generally require sedation or light anesthesia due to moderate pain caused by the shock waves. A loud noise is produced each time a shock wave is generated, and you'll wear earphones to protect your hearing.

  Your doctor will likely use X-rays or ultrasound to help determine the position of the stone as well as to monitor the status of the stone during treatment.

  Complications that may occur with ESWL include blood in the urine, bruising on the back or abdomen, bleeding around the kidney and other adjacent organs, and discomfort as the stone fragments pass through the urinary tract. In addition, if the stone doesn't shatter completely, you may need a second round of ESWL or ureteroscopic stone removal. After treatment, it may take months for all the stone fragments to pass.

- **Percutaneous nephrolithotomy.** When ESWL isn't effective, or the stone is very large, your surgeon may remove your kidney stone through a small incision in your back using an instrument called a nephroscope.

- **Ureteroscopic stone removal.** This procedure may be used to remove a stone lodged in a ureter. The stone is snared with a small instrument (ureteroscope) that's passed into the ureter through your bladder. Ultrasound or laser energy also can be directed through the scope to shatter the stone. These methods work especially well on stones in the lower part of the ureter.
- **Parathyroid surgery.** Some calcium stones are caused by overactive parathyroid glands, which are located on the four corners of your thyroid gland, just below your Adam's apple. When these glands produce too much parathyroid hormone, your body's level of calcium can become too high, resulting in excessive excretion of calcium in your urine. Most often, this is the result of a small benign tumor in one of your four parathyroid glands. A doctor can surgically remove the tumor.

Prevention

In many cases, you can prevent kidney stones by making a few lifestyle changes. If these measures aren't effective and blood and urine tests reveal a correctable chemical imbalance or that the stones you have are getting bigger, your doctor may prescribe certain medications.

Lifestyle changes
For people with a history of kidney stones, doctors usually recommend passing at least 2.5 quarts (2.3 liters) of urine a day. To do this, you'll need to drink about 14 cups (3.3 liters) of fluids every day — and even more if you live in a hot, dry climate.

What should you drink? Water is best. Include a glass of lemonade every day, too. Make your own with real lemons, or use a liquid or frozen concentrate, but avoid powdered lemonade mixes. Lemonade increases the levels of citrate in your urine, and citrate helps prevent stone formation.

In addition, if you tend to form calcium oxalate stones, your doctor may recommend restricting foods rich in oxalates. These include rhubarb, star fruit, beets, beet greens, collards, okra, refried beans, spinach, Swiss chard, sweet potatoes, sesame seeds, almonds and soy products. What's more, studies show that an overall diet low in salt and very low in animal protein can greatly reduce your chance of developing kidney stones.

As a general rule, restricting your intake of calcium doesn't seem to lower your risk. In fact, researchers have found that women with a high calcium intake are less likely to develop kidney stones than are women who consume less calcium. Why? Dietary calcium binds with oxalates in the gastrointestinal tract so that oxalates can't be absorbed from the intestine and excreted by the kidney to form stones.

An exception to this rule occurs when an individual absorbs too much dietary calcium from the intestine. In such a circumstance, restricting calcium intake is useful.

Calcium supplements seem to have the same protective effect as dietary calcium, but only if they're taken with meals.

Medications
Medications can control the level of acidity or alkalinity in your urine and may be helpful in people who form certain kinds of stones. The type of medication your doctor prescribes will depend on the kind of kidney stones you have:

- **Calcium stones.** To help prevent calcium stones from forming, your doctor may prescribe a thiazide diuretic or a phosphate-containing preparation. If you have calcium stones because of a condition known as renal tubular acidosis, your doctor may suggest taking sodium bicarbonate or potassium bicarbonate.
- **Uric acid stones.** Your doctor may prescribe allopurinol (Zyloprim, Aloprim) to reduce uric acid levels in your blood and urine and a medicine to keep your urine alkaline. In some cases, allopurinol and an alkalinizing agent may dissolve the uric acid stones.
- **Struvite stones.** To prevent struvite stones, the first goal is to keep urine free of bacteria that cause infection. Long-term use of antibiotics in small doses may be useful to achieve this goal.
- **Cystine stones.** Cystine stones are the hardest stones and the most difficult to treat. Your doctor may prescribe certain medications to alkalinize the urine or to bind the cystine in the urine in addition to recommending an extremely high urine output.

Kidney stone

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Please improve this article if you can. *(April 2008)*

"Bladder stone" redirects here. For bladder stones in animals, see Bladder stone (animal).

Kidney stone
Classification and external resources

An 8 mm kidney stone.

ICD-10	N20.0
ICD-9	592.0
DiseasesDB	11346
MedlinePlus	000458
eMedicine	med/1600
MeSH	D007669

Kidney stones, also called **renal calculi**, are solid concretions (crystal aggregations) of dissolved minerals in urine; calculi typically form inside the kidneys or bladder. The terms *nephrolithiasis* and *urolithiasis* refer to the presence of calculi in the kidneys and urinary tract, respectively.

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[edit] Overview

The kidneys are a pair of organs that are primarily responsible for filtering metabolites and minerals from the circulatory system. These secretions are then passed to the bladder and out of the body as urine. Some of the substances found in urine are able to crystalize, and in a concentrated form these chemicals can precipitate into a solid deposit attached to the kidney walls. These crystals can grow through a process of accretion to form a kidney stone.[1] In medical terminology these deposits are known as renal calculi (Latin *renal*, "kidney" and *calculi*, "pebbles").[2]

Renal calculi can vary in size from as small as grains of sand to as large as a golf ball.[3] Kidney stones typically leave the body by passage in the urine stream, and many stones are formed and passed without causing symptoms. If stones grow to sufficient size before passage—on the order of at least 2-3 millimeters—they can cause obstruction of the ureter. The resulting obstruction with dilation or stretching of the upper ureter and renal pelvis as well as spasm of muscle, trying to move the stone, can cause severe episodic pain, most commonly felt in the flank, lower abdomen and groin (a condition called renal colic). Renal colic can be associated with nausea and vomiting due to the embryological association of the kidneys with the intestinal tract. Hematuria (bloody urine) is commonly present due to damage to the lining of the urinary tract.

Within the United States, about 10–15% of adults will be diagnosed with a kidney stone,[4] and the total cost for treating this condition was US$2 billion in 2003.[5] The incidence rate increases to 20–25% in the Middle East, because of increased risk of dehydration in hot climates. (The typical Arabian diet is also 50% lower in calcium and 250% higher in oxalates compared to Western diets, increasing the net risk.)[6] Recurrence rates are estimated at about 10% per year, totalling 50% over a 5–10 year period and 75% over 20 years.[7] Men are affected approximately 4 times more often than women. Recent evidence has shown an increase in pediatric cases.[8]

[edit] History

The existence of kidney stones has been recorded since the beginning of civilization, and lithotomy for the removal of stones is one of the earliest known surgical procedures.[9] In 1901, a stone was discovered in the pelvis of an ancient Egyptian mummy, and was dated to 4,800 BCE. Medical text from ancient Mesopotamia, India, China, Persia, Greece and Rome all mentioned calculous disease. Part of the Hippocratic oath contains an admonition about the dangers of operating on the bladder for stones. The Roman medical treatise *De Medicina* by Cornelius Celsus contained a description of lithotomy, and this work served as the basis for this procedure up until the 18th century.[10]

New techniques in lithotomy began to emerge starting in 1520, but the operation remained risky. It was only after Henry J. Bigelow popularized the technique of litholopaxy in 1878 that the mortality rate dropped from about 24% down to 2.4%. However, other treatment techniques were developed that continued to produce a high level of mortality, especially among inexperienced urologists.[10][11] In 1980, Dornier MedTech introduced extracorporeal shock wave lithotripsy for breaking up stones via acoustical pulses, and this technique has come into widespread use.[12]

Among the famous leaders who were kidney stone formers are Emperor Napoleon Bonaparte, Emperor Napoleon III, Peter the Great, Louis XIV, George IV, Oliver Cromwell, and former U.S. President Lyndon B. Johnson. Other notable individuals who endured stones include Benjamin Franklin, the philosophers Michel de Montaigne and Sir Francis Bacon, the scientist Sir Isaac Newton, the civil servant and diarist Samuel Pepys, the physicians William Harvey and Herman Boerhaave, and the anatomist Antonio Scarpa.[11] Astronauts seem to show a higher risk of developing kidney stones during or after long duration space flights.[13]

[edit] Causes

Staghorn calculus

Kidney stones can be due to underlying metabolic conditions, such as renal tubular acidosis,[7] Dent's disease[14] and medullary sponge kidney.[15] Many health facilities will screen for such disorders in patients with recurrent kidney stones.[*citation needed*] This is typically done with a 24 hour urine collection that is chemically analyzed for deficiencies and excesses that promote stone formation. Kidney stones are also more common in patients with Crohn's disease.[16]

There has been some evidence that water fluoridation may increase the risk of kidney stone formation. In one study, patients with symptoms of skeletal fluorosis were 4.6 times as likely to develop kidney stones.[17] However, fluoride may also be an inhibitor of urinary stone formation.[18]

There is a longstanding belief among the mainstream medical community that vitamin C causes kidney stones, which may be based on little science.[19] Although some individual

recent studies have found a relationship[20] there is no clear relationship between excess ascorbic acid intake and kidney stone formation. [21]

[edit] Calcium oxalate stones

The most common type of kidney stone is composed of calcium oxalate crystals, occurring in about 80% of cases,[7] and the factors that promote the precipitation of crystals in the urine are associated with the development of these stones.

Common sense has long held that consumption of too much calcium could promote the development of calcium kidney stones. However, current evidence suggests that the consumption of low-calcium diets is actually associated with a higher overall risk for the development of kidney stones.[22] This is perhaps related to the role of calcium in binding ingested oxalate in the gastrointestinal tract. As the amount of calcium intake decreases, the amount of oxalate available for absorption into the bloodstream increases; this oxalate is then excreted in greater amounts into the urine by the kidneys. In the urine, oxalate is a very strong promoter of calcium oxalate precipitation, about 15 times stronger than calcium.

[edit] Uric acid (urate)

About 5–10% of all stones are formed from uric acid.[7] Uric acid stones form in association with conditions that cause hyperuricosuria with or without high blood serum uric acid levels (hyperuricemia); and with acid/base metabolism disorders where the urine is excessively acidic (low pH) resulting in uric acid precipitation. A diagnosis of **uric acid nephrolithiasis** is supported if there is a radiolucent stone, a persistent undue urine acidity, and uric acid crystals in fresh urine samples.[23]

[edit] Other types

Other types of kidney stones are composed of struvite (magnesium, ammonium and phosphate); calcium phosphate; and cystine.

The formation of struvite stones is associated with the presence of urea-splitting bacteria, most commonly *Proteus mirabilis* (but also *Klebsiella*, *Serratia*, *Providencia* species). These organisms are capable of splitting urea into ammonia, decreasing the acidity of the urine and resulting in favorable conditions for the formation of struvite stones. Struvite stones are always associated with urinary tract infections.

The formation of calcium phosphate stones is associated with conditions such as hyperparathyroidism and renal tubular acidosis.

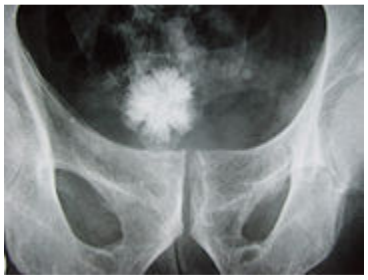
Formation of cystine stones is uniquely associated with people suffering from cystinuria, who accumulate cystine in their urine.

[edit] Symptoms

Symptoms of kidney stones include:[22][3]

- Colicky pain: "loin to groin". Often described as "the worst pain [...] ever experienced".[24]
- Hematuria: blood in the urine, due to minor damage to inside wall of kidney, ureter and/or urethra.
- Pyuria: pus in the urine.
- Dysuria: burning on urination when passing stones (rare). More typical of infection.
- Oliguria: reduced urinary volume caused by obstruction of the bladder or urethra by stone, or extremely rarely, simultaneous obstruction of both ureters by a stone.
- Abdominal distention.
- Nausea/vomiting: embryological link with intestine – stimulates the vomiting center.
- Fever and chills.
- Hydronephrosis[25]
- Postrenal azotemia: when kidney stone blocks ureter[26]

[edit] Diagnosis



Star shaped bladder urolith on an X-ray of the pelvis.

Clinical diagnosis is usually made on the basis of the location and severity of the pain, which is typically colic in nature (comes and goes in spasmodic waves). Pain in the back occurs when calculi produce an obstruction in the kidney.[3]

Imaging is used to confirm the diagnosis and a number of other tests can be undertaken to help establish both the possible cause and consequences of the stone. Ultrasound imaging is also useful as it will give details about the presence of hydronephrosis (swelling of the kidney—suggesting the stone is blocking the outflow of urine).[5] It can also be used to show the kidneys during pregnancy when standard x-rays are discouraged. About 10% of stones do not have enough calcium to be seen on standard x-rays (radiolucent stones) and may show up on ultrasound although they typically are seen on CT scans.

The relatively dense calcium renders these stones radio-opaque and they can be detected by a traditional X-ray of the abdomen that includes the Kidneys, Ureters and Bladder—KUB.[5] This may be followed by an IVP (Intravenous Pyelogram; (IntraVenous Urogram (IVU) is the same test by another name)) which requires about 50 ml of a special dye to

be injected into the bloodstream that is excreted by the kidneys and by its density helps outline any stone on a repeated X-ray. These can also be detected by a Retrograde pyelogram where similar "dye" is injected directly into the ureteral opening in the bladder by a surgeon, usually a urologist.

Computed tomography (CT or CAT scan), a specialized X-ray, is considered the gold-standard diagnostic test for the detection of kidney stones, and in this setting does not require the use of intravenous contrast, which carries some risk in certain people (eg, allergy, kidney damage). All stones are detectable by CT except very rare stones composed of certain drug residues in the urine.[5] The non-contrast "renal colic study" CT scan has become the standard test for the immediate diagnosis of flank pain typical of a kidney stone. If positive for stones, a single standard x-ray of the abdomen (KUB) is recommended. This additional x-ray provides the physicians with a clearer idea of the exact size and shape of the stone as well as its surgical orientation. Further, it makes it simple to follow the progress of the stone without the need for the much more expensive CT scan just by doing another single x-ray at some point in the future.

Other investigations typically carried out include:[5]

- Microscopic study of urine, which may show proteins, red blood cells, bacteria, cellular casts and crystals.
- Culture of a urine sample to exclude urine infection (either as a differential cause of the patient's pain, or secondary to the presence of a stone)
- Blood tests: Full blood count for the presence of a raised white cell count (Neutrophilia) suggestive of infection, a check of renal function and to look for abnormally high blood calcium blood levels (hypercalcaemia).
- 24 hour urine collection to measure total daily urinary volume, magnesium, sodium, uric acid, calcium, citrate, oxalate and phosphate.
- Catching of passed stones at home (usually by urinating through a tea strainer) for later examination and evaluation by a doctor.[27][28]

[edit] Treatment

[edit] Temporizing

About 90% of stones 4 mm or less in size usually will pass spontaneously, however 99% of stones larger than 6 mm will require some form of intervention.[29] There are various measures that can be used to encourage the passage of a stone. These can include increased hydration, medication for treating infection and reducing pain, and diuretics to encourage urine flow and prevent further stone formation. Eating starfruit can be effective at reducing pain and improving urination.[3] However caution should be exercised due to other concerns with the ingestion of starfruit.[30]

In most cases, a smaller stone that is not symptomatic is often given up to four weeks[22] to move or pass before consideration is given to any surgical intervention as it has been found that waiting longer tends to lead to additional complications. Immediate surgery

may be required in certain situations such as in people with only one working kidney, intractable pain or in the presence of an infected kidney blocked by a stone which can rapidly cause severe sepsis and toxic shock.

[edit] Analgesia

Management of pain from kidney stones varies from country to country and even from physician to physician, but usually requires intravenous administration of narcotics in an emergency room setting for acute situations. Similar classes of drugs may be reasonably effective orally in an outpatient setting for less severe discomfort where nonsteroidal anti-inflammatories or narcotics like codeine can be prescribed. Some doctors will give patients with recurring passing of small stones a small supply prescription for hydrocodone to avoid a future visit to the ER when the next episode occurs. Taken at the first sign of pain, hydrocodone can eliminate much of the acute pain, nausea and vomiting which necessitates the hospital visit and still facilitate stone passage, although a follow-up with a physician is still necessary.

Patients who are to be treated non-surgically, may also be started on an alpha adrenergic blocking agent (such as Flomax, Uroxatral, terazosin or doxazosin), which acts to reduce the muscle tone of the ureter and facilitate stone passage. For smaller stones near the bladder, this type of medical treatment can increase the spontaneous stone passage rate by about 30%.

After treatment, the pain may return if the stone moves but re-obstructs in another location. Patients are encouraged to strain their urine so they can collect the stone when it eventually passes and send it for chemical composition analysis which will be used along with a 24 hour urine chemical analysis test to establish preventative options.

[edit] Urologic interventions

A kidney stone at the tip of an ultrasonic instrument.

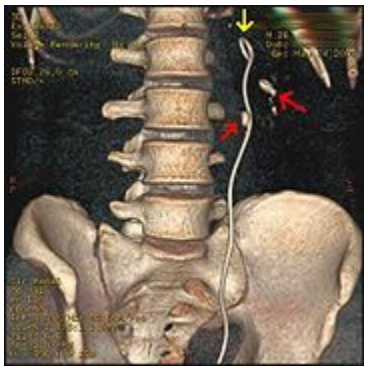
Bladder stones incidentally found in a bladder diverticulum during transvesical prostatectomy (removal of the prostate via an incision in the bladder).

Most kidney stones do not require surgery and will pass on their own. Surgery is necessary when the pain is persistent and severe, in renal failure and when there is a kidney infection. It may also be advisable if the stone fails to pass or move after 30 days. Finding a significant stone before it passes into the ureter allows physicians to fragment it surgically before it causes any severe problems. In most of these cases, non-invasive Extracorporeal Shock Wave Lithotripsy (ESWL) will be used. Otherwise some form of invasive procedure is required; with approaches including ureteroscopic fragmentation (or simple basket extraction if feasible) using laser, ultrasonic or mechanical (pneumatic, shock-wave) forms of energy to fragment the larger stones. Percutaneous nephrolithotomy or rarely open surgery may ultimately be necessary for large or complicated stones or stones which fail other less invasive attempts at treatment.

A single retrospective study in the USA, at the Mayo Clinic, has suggested that lithotripsy may increase subsequent incidence of diabetes and hypertension,[31] but it has not been felt warranted to change clinical practice at the clinic.[32] The study reflects early experience with the original lithotripsy machine which had a very large blast path, much larger than what is used on modern machines. Further study is believed necessary to determine how much risk this treatment actually has using modern machines and treatment regimens.

More common complications related to ESWL are bleeding, pain related to passage of stone fragments, failure to fragment the stone, and the possible requirement for additional or alternative interventions.

[edit] Ureteral (double-J) stents



Three-dimensional reconstructed CT scan image of a ureteral stent in the left kidney (indicated by yellow arrow). There is a kidney stone in the pyelum of the lower pole of the kidney (highest red arrow) and one in the ureter beside the stent (lower red arrow).

One modern medical technique uses a ureteral stent (a small tube between the bladder and the inside of the kidney) to provide immediate relief of a blocked kidney. This is especially useful in saving a failing kidney due to swelling and infection from the stone.

Ureteral stents vary in length and width but most have the same shape usually called a "double-J" or "double pigtail", because of the curl at both ends. They are designed to allow urine to drain around any stone or obstruction. They can be retained for some length of time as infections recede and as stones are dissolved or fragmented with ESWL or other treatment. The stents will gently dilate or stretch the ureters which can facilitate instrumentation and they will also provide a clear landmark to help surgeons see the stones on x-ray. Most stents can be removed easily during a final office visit. Discomfort levels from stents typically range from minimal associated pain to moderate discomfort.

[edit] Prevention

Preventive strategies include dietary modifications and sometimes also taking drugs with the goal of reducing excretory load on the kidneys:[33][22]

- Drinking enough water to make 2 to 2.5 liters of urine per day.
- A diet low in protein, nitrogen and sodium intake.
- Restriction of oxalate-rich foods, such as chocolate, nuts, soybeans,[34] rhubarb and spinach, plus maintenance of an adequate intake of dietary calcium. There is equivocal evidence that calcium supplements increase the risk of stone formation, though calcium citrate appears to carry the lowest, if any, risk.
- Taking drugs such as thiazides, potassium citrate, magnesium citrate and allopurinol, depending on the cause of stone formation.
- Some fruit juices, such as orange, blackcurrant, and cranberry, may be useful for lowering the risk factors for specific types of stones.[35][36]
- Avoidance of cola beverages.[37][38]
- Avoiding large doses of vitamin C.[39]

For those patients interested in optimizing their kidney stone prevention options, it's essential to have a 24 hour urine test performed. This should be done with the patient on his or her regular diet and activities. The results can then be analyzed for abnormalities and appropriate treatment given.

[edit] Restricting Oxalate consumption

The neutrality of this article is disputed.
Please see the discussion on the talk page. *(July 2008)*
Please do not remove this message until the dispute is resolved.

Calcium plays a vital role in body chemistry so limiting Calcium is unhealthy. Since Calcium in the intestinal tract will bind with available Oxalate, thereby preventing its absorption into the blood stream, some Nephrologists recommend chewing Calcium tablets during meals containing Oxalate foods. However, a more reliable approach is to restrict the intake of food that is high in Oxalate.

[show]**Common high-Oxalate foods**[40]

[edit] Diuretics

Although it has been claimed that the diuretic effects of alcohol can result in dehydration, which is important for kidney stone sufferers to avoid, there are no conclusive data demonstrating any cause and effect regarding kidney stones. However, some have theorized that frequent and binge drinkers create situations that set up dehydration: alcohol consumption, hangovers, and poor sleep and stress habits. In this view, it is not the alcohol that creates a kidney stone but it is the alcohol drinker's associated behavior that sets it up.[41]

One of the recognized medical therapies for prevention of stones is thiazides, a class of drugs usually thought of as diuretics. These drugs prevent stones through an effect independent of their diuretic properties: they reduce urinary calcium excretion. Nonetheless, their diuretic property does not preclude their efficacy as stone preventive. Sodium restriction is necessary for clinical effect of thiazides, as sodium excess promotes calcium excretion. Though some have said that the effect probably fades after two years or so of therapy (tachyphylaxis), in fact it is only randomized controlled trials lasting 2 years or more that show the effect; there is really no good evidence from studies of calcium metabolism that the thiazide effect does not last indefinitely. Thiazides are the medical therapy of choice for most cases of hypercalciuria (excessive urinary calcium) but may not be suitable for all calcium stone formers; just those with high urinary calcium levels.

[edit] Allopurinol

Allopurinol (*Zyloprim*) is another drug with proven benefits in some calcium kidney stone formers. Allopurinol interferes with the liver's production of uric acid. Hyperuricosuria, too much uric acid in the urine, is a risk factor for calcium stones. Allopurinol reduces calcium stone formation in such patients. The drug is also used in patients with gout or hyperuricemia, but the latter is not the critical feature of uric acid stones.[42] Uric acid stones are more often caused by low urine pH. Even relatively high uric acid excretion will not be associated with uric acid stone formation if the urine pH is alkaline. Therefore prevention of uric acid stones relies on alkalinization of the urine with citrate.

Allopurinol is reserved for patients in whom alkalinization is difficult. For patients with increased uric acid levels and calcium stones, allopurinol is one of the few treatments that has been shown in double-blinded placebo controlled studies to actually reduce kidney stone recurrences. Dosage is adjusted to maintain a reduced urinary excretion of uric acid. Serum uric acid level at or below 6 mg/dL is often the goal of the drug's use in patients with gout or hyperuricemia.

[edit] Decreased protein diet

A high protein diet might be partially to blame. Protein from meat and other animal products is broken down into acids, including uric acid. The most available alkaline base

to balance the acid from protein is calcium phosphate (hydroxyapatite) from the bones (buffering). The kidney filters the liberated calcium which may then form insoluble crystals (i.e., stones) in urine with available oxalate (partly from metabolic processes, partly from diet) or phosphate ions, depending on conditions. High protein intake is therefore associated with decreased bone density as well as stones. The acid load is associated with decreased urinary citrate excretion; citrate competes with oxalate for calcium and can thereby prevent stones.

In addition to increased fluid intake, one of the simplest fixes is to moderate animal protein consumption. However, despite epidemiologic data showing that greater protein intake is associated with more stones, randomized controlled trials of protein restriction have not shown reduced stone prevalence. In this regard, it is not just dietary calcium per se that may cause stone formation, but rather the leaching of bone calcium. Some diseases (e.g., distal renal tubular acidosis) which cause a chronically acidic state also decrease urinary citrate levels; since citrates are normally present as potent inhibitors of stone formation, these patients are prone to frequent stone formation.

[edit] Other modifications

Potassium citrate is also used in kidney stone prevention. This is available as both a tablet and liquid preparation. The medication increases urinary pH (makes it more alkaline), as well as increases the urinary citrate level, which helps reduce calcium oxalate crystal aggregation. Optimal 24 hour urine levels of citrate are thought to be over 320 mg/liter of urine or over 600 mg per day. There are urinary dipsticks available that allow patients to monitor and measure urinary pH so patients can optimize their urinary citrate level.

Though caffeine does acutely increase urinary calcium excretion, several independent epidemiologic studies have shown that coffee intake overall is protective against the formation of stones.[43]

Measurements of food oxalate content have been difficult and issues remain about the proportion of oxalate that is bio-available, versus a proportion that is not absorbed by the intestine. Oxalate-rich foods are usually restricted to some degree, particularly in patients with high urinary oxalate levels, but no randomized controlled trial of oxalate restriction has been performed to test that hypothesis.

[edit] Calgranulin

Crystallization of calcium oxalate (CaOx) appears to be reduced by molecules in the urine that retard the formation, growth, aggregation, and renal cell adherence of calcium oxalate. By purifying urine using salt precipitation, preparative isoelectric focusing, and sizing chromatography, some researchers have found that the molecule calgranulin is able to inhibit calcium oxalate crystal growth.[44] Calgranulin is a protein formed in the kidney. Given the large amounts of calcium oxalate in the urine, and considering its

potency, calgranulin could become an important contribution to the normal urinary inhibition of crystal growth and aggregation. If so, it will be an important tool in the renal defense against kidney stones.

Minimally Invasive Treatment of Urinary Stones

Treatment of Large Kidney Stones by Percutaneous Nephrolithotomy: Outcomes and Data

Douglas Modling, Jr., M.D.
Board Certified-Board of Urology
Endourological Society
Urology Centers of Alabama, P.C.

Many patients with stones too large to be fragmented into smaller pieces and passed require percutaneous nephrolithotomy. This procedure uses a needle to gain access into the kidney at a specific location. A wire is placed and a tract dilated to allow passage of a nephroscope to fragment and remove large stones without having to pass them.

I perform these procedures for 15 urologists at Urology Centers of Alabama, Birmingham, Alabama, and other regional urologists who refer patients for treatment. My technique is done with the patient under anesthesia for the entire procedure, and I obtain the access into the area of the kidney that allows the best chance of stone removal. Some urologists will send their patients to Radiology for a local access procedure and then to surgery for stone removal.

If the stone is not too large (<2.5 cm), it can often be removed at one procedure. If it is too large (>2.5 cm) or involves the entire collecting system (staghorn calculus), multiple procedures such as percutaneous nephrolithotomy, lithotripsy, or ureteroscopy may be needed to remove the stone.

In the community setting, a urologist will perform approximately five per year. We feel having one surgeon performing these procedures allows for better patient care resulting in less OR time and increased chance of retrieving the stones.

We have accumulated data for 1993 through 2007 as follows:

Total PCNL's	232
Stone free	95% (70% after the first procedure; 25% after additional procedures)

Additional procedures needed: Second PCNL, lithotripsy (stone fragmentation externally), ureteroscopy, hospital stay an average of 2.8 days

Complication rate: 6.9% overall (most minor such as UTI, pain, nausea, fluid in pleural area)

Major complications:	Deaths	0	0%
	Pulmonary embolus	1/232	0.4%
	Perinephric hematoma	1/232	0.4%
	Persistent bleeding Treatment	3/232	1.2%
	Transfusion	5/232	2%

Bleeding was evaluated with arteriogram in 2/232, the vessel was embolized resolving the bleeding, and no abnormality was seen. In all others persistent bleeding resolved and was thought to be from a UTI.

In summary, large renal stones greater than 2.5 cm often require PCNL, a minimally invasive procedure, to be removed. Overall, success rates are 95%. Some patients require multiple procedures to safely remove all stone. We always attempt to remove all stone at one setting if we are able to do so. Our technique of obtaining the access allows the entire procedure to be done under anesthesia.

Specific Kidney Stone Prevention

The old saying that "an ounce of prevention is worth a pound of cure" certainly applies to kidney stones. The general recommendations for kidney stone prevention are very helpful. For patients who are having frequent stones or require surgical procedures for treatment of stones, a metabolic evaluation which consists of blood tests, urine tests, imaging (if necessary) and stone analysis can be done to determine the exact defect that is causing the kidney stones. This metabolic evaluation is very effective and can decrease stone formation rates up to 80 percent.

The process is simple: 1) a visit to a qualified physician for a history, physical examination, blood tests, stone analysis, imaging studies (if needed), and to set up the urine tests. 2) evaluation of the results of the tests and a decision by the physician regarding the use of medication and specific dietary recommendations. 3) education of the patient about the findings and adherence by the patient to the recommendations.

We now have many exciting and less invasive technologies to treat kidney stones which avoid the prolonged postop recoveries that were needed in the past. More important and much better for the patient than employing these less invasive procedures is not having a stone in the first place. We now have the knowledge and technology to prevent most stones so this is an option which should be considered if you are someone who has frequent stones or has had a procedure for treatment of stones in the past.

General Kidney Stone Prevention

The most common cause for kidney stones is an inherited tendency to form stones. At the present time, there is no way to change this genetic tendency, but changing what you eat and drink can reduce or stop the formation of stones.

1) Avoid salt and salty foods (this is the most important of the instructions).

2) Reduce protein intake. Red meat and organ meat (including liver, pancreas, wieners and sausages) are the worst offenders. Poultry and fish in moderation are okay. Vegetable protein (soy) is okay.

3) Drink large amounts of fluid, especially water (2-3 quarts per day, or one 8 ounce glass of water every three hours). A good index is to check the color of the urine. If it appears to be concentrated, you need to drink more water. Adding lemon juice to the water is helpful since this will get citrate into the urine. Citrate helps to prevent stones, so lemonade and orange juice are good fluids to drink.

4) Avoid excess foods or fluid containing oxalate. The worst offenders for oxalate are tea and dark green vegetables (turnips and spinach). Other foods that contain significant amounts of oxalate are as follows:

- potatoes
- beets
- chocolate or cocoa
- bell peppers
- wheat germ
- nuts

5) For most patients, moderate dietary calcium intake (dairy products) is okay, but some calcium supplements (Tums, Rolaids, etc.) may increase the risk for stone formation. This risk is decreased by taking these medications with meals. If calcium supplementation is recommended, the calcium supplement CITRACAL is less likely to form stones, especially when taken with meals. Restricting calcium intake is only useful in the patients who absorb too much dietary calcium from the intestine which is determined by calcium absorption tests.

Curious about the different types of kidney stones?

Calcium Oxalate Stones
The most common kidney stone is made of calcium oxalate. Calcium is a main constituent of bone and is always present in blood and urine. Oxalate is a by-product of metabolism and is also present in many foods. When they combine in the kidneys, calcium and oxalate produce a very insoluble salt that easily forms a solid stone. Once they form, these stones can never dissolve and must be passed or broken up by a surgeon using modern technologies.

Calcium Phosphate Stones
Less common are calcium phosphate stones. Calcium phosphate crystals are the stiffener that makes bone rigid. Large amounts of phosphate from food are eliminated in the urine of normal people every day. The usual cause of calcium phosphate stones is a disease that increases urine calcium and also makes the urine abnormally alkaline. When the urine is

not alkaline, high urine calcium concentrations produce mainly calcium oxalate stones, but when the urine is alkaline, calcium is bound by urine phosphorus, and calcium phosphate stones are produced. Minor amounts of calcium phosphate are usual in calcium oxalate stones and have no clinical significance. When the bulk of the stone (more than half) is calcium phosphate, special treatment is often needed.

Uric Acid Stones
Also less common but very important are stones made of uric acid. These can either be pure uric acid or a mixture of uric acid with calcium oxalate. Uric acid is a breakdown product of DNA and RNA and crystallizes into stones whenever the urine is chronically acid in character. Uric acid stones can dissolve if the urine can be made to be less acid. Causes of abnormally acidic urine include heredity, gout, renal disease, and intestinal disease, as well as dietary extremes.

Struvite Stones
Stones composed of struvite (magnesium, ammonium, and phosphate) are always produced by infection. Some bacteria that infect the kidneys and urinary tract can break down urea, a universal constituent of urine, to ammonia. The ammonia makes the urine in the vicinity of the bacteria extremely alkaline, and the normal amounts of magnesium and phosphorus present in all urine form crystals with dissolved ammonia and make this large type of stone. Unlike calcium oxalate and most calcium phosphate stones, struvite stones can rapidly grow so large as to fill the entire interior of the kidney drainage system. There are two types of struvite stone-forming patients, and they require completely different treatments.

Cystine Stones
This uncommon stone is made of the amino acid cystine and occurs only in patients who have an inherited disease called cystinuria. Urine can dissolve no more than 300 mg of cystine in a liter, and normal people lose less than 100 mg daily in their urine. Cystine is present in blood and filtered from blood by the kidney in very large amounts. People with cystinuria lack the renal mechanisms to reclaim the filtered cystine back into the blood. This valuable nutrient is lost in the urine and makes large and potentially dangerous stones, often beginning in infancy or childhood.

Unusual Stones
Certain antiviral drugs, as well as triamterene (a diuretic) are well known to cause kidney stone formation. Hydroxyadenine stones form in people who have a very rare inherited enzyme deficiency that causes over production of the material.

Kidney Stones (also known as renal stones, renal calculus)

Causes, Prevention, and Treatment

CAUSES

Kidney stones can run in families, but there are environmental factors for many patients.

Some causes of stones include:

Dehydration

Diet (too much oxalate, too much protein, or rarely too much calcium)

Atkins diet

Inflammatory bowel disease

Gout

Urinary tract infections

Vitamin C (over 2 grams per day)

Calcium supplements if taken without food or if used excessively

Your mother was wrong! It is now known that a LOW CALCIUM DIET will result in MORE STONES for the majority of stone patients. It does not make immediate sense but the majority of patients who make stones DO NOT have a calcium problem. Calcium is most often "just along for the ride." It is not recommended to decrease dairy calcium consumption unless you have had a metabolic evaluation that showed high urinary calcium which decreased on a low calcium diet.

TREATMENT OF KIDNEY STONES

Medical treatment

The role of medicine and diet for kidney stone treatment is mainly for the prevention of future stones or to prevent the growth of existing stones. Prevention will be addressed below.

In rare instances, stones can be dissolved. This is only effective for a smaller, purely uric acid stone and requires frequent medication adjustments and at-home urine testing up to 4 times per day by the patient.

For 90% of stones, there is no proven way to dissolve them or to medically treat a stone that has already formed.

Treatment options for most patients: non invasive, minimally invasive, and surgical procedures for kidney stone treatment and kidney stone removal.

In general, there are FIVE options available to treat all urinary tract stones. Kidney stone size and location is an important factor in deciding which treatment is best for you.

1. Do nothing: This is best saved for very small stones that could pass easily, or for very large asymptomatic stones in older patients. However, if the stone is causing pain, blockage or infections, it should be treated.

2. Lithotripsy (shock wave lithotripsy, SWL, ESWL): It is the easiest procedure. The patient lies on a table or in a tub and shock waves are focused on the stone. It is non-invasive, but if the stone is over 1 cm, you will likely need a cystoscopy and stent to help the pieces pass. Patients can go home the same day. Lithotripsy is only 60 - 85% effective for making your kidney or ureter stone free in a single treatment (depending on stone size and location) . The recurrence rate is quite high. 42% of patients will have another stone within two years, probably from small fragments left behind that grow into new stones.

3. Endoscopic treatment (ureteroscopy, with or without laser stone fragmentation): A urologist can look inside the bladder and all the way up to the kidney with a small scope and either remove the stone or break it up with a laser and remove the pieces. It is minimally invasive. There is no incision as the instruments go through the patient's existing "plumbing." Patients can go home the same day. In experienced hands, the stone free rate is 90-95% for stones in the ureter. The stone free rate is 80-90% for stones in the kidney depending on size and location.

4. Percutaneous removal (also called percutaneous nephrolithotomy, PCNL): Very few urologists are proficient at this technique, which is why many urologists will not offer it as an option for their patients. PCNL is the treatment of choice for stones over 15 - 20 mm (1.5 to 2 cm). **Associated Urologists of Orange County routinely uses this technique for patients with large stones or stones refractory to other procedures.**

While it is minimally invasive, it requires a one inch incision in the back. A channel is made from the skin straight into the kidney. It is invasive, but still considered minimally-invasive. Patients typically spend one night in the hospital (two for older patients). The stone free rate is 90 - 95% for these very large stones that otherwise would require multiple procedures to completely clear.

5. Open surgery: It is extremely rare to need a large incision to remove a stone from the urinary tract.

The choice of treatment will depend on the size and location of the stone. In addition, the more invasive the procedure, the higher the success rate.

KIDNEY STONE PREVENTION

Everyone in the emergency room with a stone loudly proclaims "I will do anything to avoid another stone." In reality, very few people will stay on a prophylactic treatment program for many years. Once they feel better, they stop therapy until

the next painful stone. The average person who passes a small stone without the need for a procedure (whether it is his first stone or it has been many years since the previous stone) will not benefit much from specific testing and treatment. They are also unlikely to stay on any treatment recommended.

Kidney stone prevention is most important for patients with recurrent stones, multiple stones at one time or patients with very large or difficult to treat stones. Testing includes a 24-hour urine collection, blood testing and chemical analysis of the stone if possible. The possible treatments include diet changes (usually low oxalate diet or decreasing protein), citrate or magnesium supplementation and occasionally medication.

Contact us at (714) 639-1915 to make an appointment to discuss treatment and prevention of kidney stones.
Dr. Garo M. Tertzakian MD
Dr. Matthew L. Greenberger MD
Dr. William F. Pearce MD
Associated Urologists of Orange County

Doctors with expertise in incontinence, bladder suspension ("bladder lift") and sling procedures, kidney stones, no needle no scalpel vasectomy, vasectomy reversal, laparoscopy and laparoscopic kidney and prostate surgery, prostate diseases including cancer and enlarged prostate

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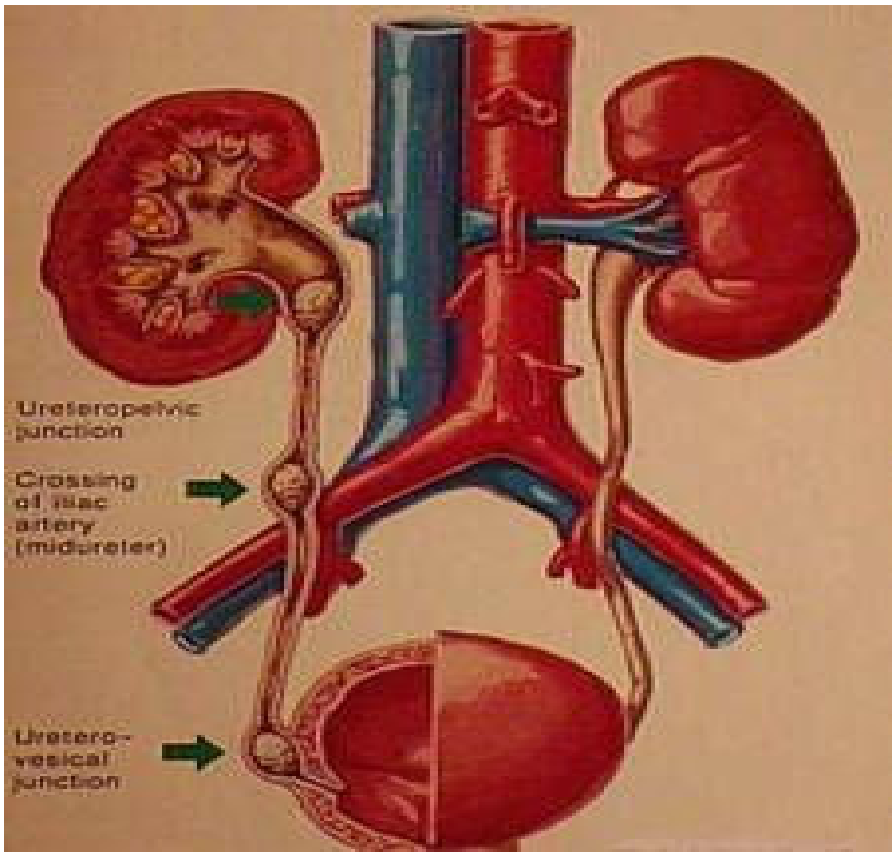
OVERVIEW

Kidney stones are also known as calculi (plural), or calculus (singular). When it is in the kidney, it is a renal calculus. The tube draining the kidney to the bladder is the ureter, and a stone in the ureter is a ureteral calculus.

It is estimated that 20% of us will have a kidney stone in our lifetime. Of those who get a stone, 50% will recur.

Passing a stone is usually very painful. However, many patients can pass a stone with only a "muscle ache" sensation in the back, and they may not be aware the pain was from a stone until it "pops out."


Ureteropelvic junction
Crossing of iliac artery (midureter)
Uretero-vesical junction