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A service of the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), NIH



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Kidney Stones in Adults

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Kidney stones, one of the most painful of the urologic disorders, are not a product of modern life. Scientists have found evidence of kidney stones in a 7,000-year-old Egyptian mummy. Unfortunately, kidney stones are one of the most common disorders of the urinary tract. In 2000, patients made 2.7 million visits to health care providers and more than 600,000 patients went to emergency rooms for kidney stone problems. Men tend to be affected more frequently than women.

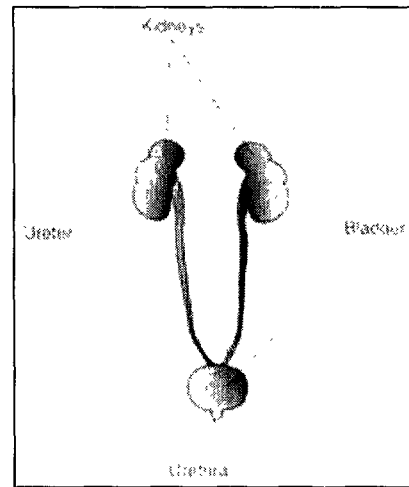
Most kidney stones pass out of the body without any intervention by a physician. Stones that cause lasting symptoms or other complications may be treated by various techniques, most of which do not involve major surgery. Also, research advances have led to a better understanding of the many factors that promote stone formation.

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Introduction to the Urinary Tract

The urinary tract, or system, consists of the kidneys, ureters,

bladder, and urethra. The kidneys are two bean-shaped organs located below the ribs toward the middle of the back. The kidneys remove extra water and wastes from the blood, converting it to urine. They also keep a stable balance of salts and other substances in the blood. The kidneys produce hormones that help build strong bones and help form red blood cells.



The urinary tract

Narrow tubes called ureters carry urine from the kidneys to the bladder, an oval-shaped chamber in the lower abdomen. Like a balloon, the bladder's elastic walls stretch and expand to store urine. They flatten together when urine is emptied through the urethra to outside the body.

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What is a kidney stone?

A kidney stone is a hard mass developed from crystals that separate from the urine and build up on the inner surfaces of the kidney. Normally, urine contains chemicals that prevent or inhibit the crystals from forming. These inhibitors do not seem to work for everyone, however, so some people form stones. If the crystals remain tiny enough, they will travel through the urinary tract and pass out of the body in the urine without being noticed.

Kidney stones may contain various combinations of chemicals. The most common type of stone contains calcium in combination with either oxalate or phosphate. These chemicals are part of a person's normal diet and make up important parts of the body, such as bones and muscles.

A less common type of stone is caused by infection in the urinary tract. This type of stone is called a struvite or infection stone. A bit less common is the uric acid stone. Cystine stones are rare.

Urolithiasis is the medical term used to describe stones occurring in the urinary tract. Other frequently used terms are urinary tract stone disease and nephrolithiasis. Doctors also use terms that describe the location of the

stone in the urinary tract. For example, a ureteral stone (or ureterolithiasis) is a kidney stone found in the ureter. To keep things simple, however, the term "kidney stones" is used throughout this fact sheet.

Gallstones and kidney stones are not related. They form in different areas of the body. If you have a gallstone, you are not necessarily more likely to develop kidney stones.

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Who gets kidney stones?

For unknown reasons, the number of people in the United States with kidney stones has been increasing over the past 30 years. The prevalence of stone-forming disease rose from 3.8 percent in the late 1970s to 5.2 percent in the late 1980s and early 1990s. White Americans are more prone to develop kidney stones than African Americans. Stones occur more frequently in men. The prevalence of kidney stones rises dramatically as men enter their 40s and continues to rise into their 70s. For women, the prevalence of kidney stones peaks in their 50s. Once a person gets more than one stone, others are likely to develop.

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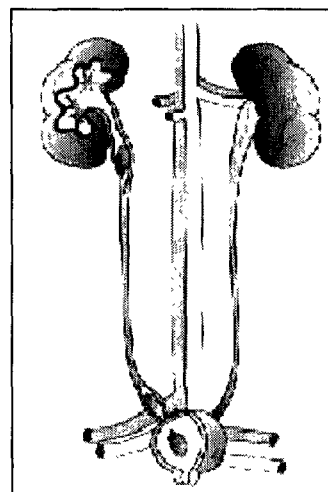
What causes kidney stones?

Doctors do not always know what causes a stone to form. While certain foods may promote stone formation in people who are susceptible, scientists do not believe that eating any specific food causes stones to form in people who are not susceptible.

A person with a family history of kidney stones may be more likely to develop stones. Urinary tract infections, kidney disorders such as cystic kidney diseases, and certain metabolic disorders such as hyperparathyroidism are also linked to stone formation.

In addition, more than 70 percent of people with a rare hereditary disease called renal tubular acidosis develop kidney stones.

Cystinuria and hyperoxaluria are two other rare, inherited

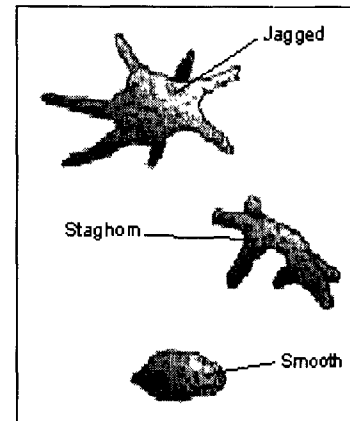


Kidney stones in kidney, ureter and bladder

metabolic disorders that often cause kidney stones. In cystinuria, too much of the amino acid cystine, which does not dissolve in urine, is voided. This can lead to the formation of stones made of cystine. In patients with hyperoxaluria, the body produces too much of the salt oxalate. When there is more oxalate than can be dissolved in the urine, the crystals settle out and form stones.

Hypercalciuria is inherited. It is the cause of stones in more than half of patients. Calcium is absorbed from food in excess and is lost into the urine. This high level of calcium in the urine causes crystals of calcium oxalate or calcium phosphate to form in the kidneys or urinary tract.

Other causes of kidney stones are hyperuricosuria which is a disorder of uric acid metabolism, gout, excess intake of vitamin D, urinary tract infections, and blockage of the urinary tract. Certain diuretics which are commonly called water pills or calcium-based antacids may increase the risk of forming kidney stones by increasing the amount of calcium in the urine.



Shapes of various stones
Sizes are usually smaller than shown here.

Calcium oxalate stones may also form in people who have a chronic inflammation of the bowel or who have had an intestinal bypass operation, or ostomy surgery. As mentioned above, struvite stones can form in people who have had a urinary tract infection. People who take the protease inhibitor indinavir, a drug used to treat HIV infection, are at risk of developing kidney stones.

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What are the symptoms?

Kidney stones often do not cause any symptoms. Usually, the first symptom of a kidney stone is extreme pain, which occurs when a stone acutely blocks the flow of urine. The pain often begins suddenly when a stone moves in the urinary tract, causing irritation or blockage. Typically, a person feels a sharp, cramping pain in the back and side in the area of the kidney or in the lower abdomen. Sometimes nausea and vomiting occur. Later, pain may spread to the groin.

If the stone is too large to pass easily, pain continues as the

muscles in the wall of the tiny ureter try to squeeze the stone along into the bladder. As a stone grows or moves, blood may appear in the urine. As the stone moves down the ureter closer to the bladder, you may feel the need to urinate more often or feel a burning sensation during urination.

If fever and chills accompany any of these symptoms, an infection may be present. In this case, you should contact a doctor immediately.

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How are kidney stones diagnosed?

Sometimes "silent" stones—those that do not cause symptoms—are found on x rays taken during a general health exam. If they are small, these stones would likely pass out of the body unnoticed.

More often, kidney stones are found on an x ray or sonogram taken on someone who complains of blood in the urine or sudden pain. These diagnostic images give the doctor valuable information about the stone's size and location. Blood and urine tests help detect any abnormal substance that might promote stone formation.

The doctor may decide to scan the urinary system using a special test called a CT (computed tomography) scan or an IVP (intravenous pyelogram). The results of all these tests help determine the proper treatment.

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How are kidney stones treated?

Fortunately, surgery is not usually necessary. Most kidney stones can pass through the urinary system with plenty of water (2 to 3 quarts a day) to help move the stone along. Often, you can stay home during this process, drinking fluids and taking pain medication as needed. The doctor usually asks you to save the passed stone(s) for testing. (You can catch it in a cup or tea strainer used only for this purpose.)

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The First Step: Prevention

If you've had more than one kidney stone, you are likely to form another; so prevention is very important. To prevent stones

from forming, your doctor must determine their cause. He or she will order laboratory tests, including urine and blood tests. Your doctor will also ask about your medical history, occupation, and eating habits. If a stone has been removed, or if you've passed a stone and saved it, the laboratory should analyze it because its composition helps in planning treatment.

You may be asked to collect your urine for 24 hours after a stone has passed or been removed. The sample is used to measure urine volume and levels of acidity, calcium, sodium, uric acid, oxalate, citrate, and creatinine (a product of muscle metabolism). Your doctor will use this information to determine the cause of the stone. A second 24-hour urine collection may be needed to determine whether the prescribed treatment is working.

Lifestyle Changes

A simple and most important lifestyle change to prevent stones is to drink more liquids—water is best. If you tend to form stones, you should try to drink enough liquids throughout the day to produce at least 2 quarts of urine in every 24-hour period.

People who form calcium stones used to be told to avoid dairy products and other foods with high calcium content. But recent studies have shown that foods high in calcium, including dairy products, may help prevent calcium stones. Taking calcium in pill form, however, may increase the risk of developing stones.

You may be told to avoid food with added vitamin D and certain types of antacids that have a calcium base. If you have very acidic urine, you may need to eat less meat, fish, and poultry. These foods increase the amount of acid in the urine.

To prevent cystine stones, you should drink enough water each day to dilute the concentration of cystine that escapes into the urine, which may be difficult. More than a gallon of water may be needed every 24 hours, and a third of that must be drunk during the night.

Foods and Drinks Containing Oxalate

People prone to forming calcium oxalate stones may be asked by their doctor to cut back on certain foods if their urine contains an excess of oxalate:

- beets

- chocolate
- coffee
- cola
- nuts
- rhubarb
- spinach
- strawberries
- tea
- wheat bran

People should not give up or avoid eating these foods without talking to their doctor first. In most cases, these foods can be eaten in limited amounts.

Medical Therapy

The doctor may prescribe certain medications to prevent calcium and uric acid stones. These drugs control the amount of acid or alkali in the urine, key factors in crystal formation. The drug allopurinol may also be useful in some cases of hyperuricosuria.

Doctors usually try to control hypercalciuria, and thus prevent calcium stones, by prescribing certain diuretics, such as hydrochlorothiazide. These drugs decrease the amount of calcium released by the kidneys into the urine by favoring calcium retention in bone. They work best when sodium intake is low.

Very rarely, patients with hypercalciuria may be given the drug sodium cellulose phosphate, which binds calcium in the intestines and prevents it from leaking into the urine.

If cystine stones cannot be controlled by drinking more fluids, your doctor may prescribe drugs such as Thiola and Cuprimine, which help reduce the amount of cystine in the urine.

For struvite stones that have been totally removed, the first line of prevention is to keep the urine free of bacteria that can cause infection. Your urine will be tested regularly to be sure that no bacteria are present.

If struvite stones cannot be removed, your doctor may prescribe a drug called acetohydroxamic acid (AHA). AHA is used with long-term antibiotic drugs to prevent the infection that leads to stone growth.

People with hyperparathyroidism sometimes develop calcium

stones. Treatment in these cases is usually surgery to remove the parathyroid glands (located in the neck). In most cases, only one of the glands is enlarged. Removing the glands cures the patient's problem with hyperparathyroidism and with kidney stones as well.

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Surgical Treatment

Surgery should be reserved as an option for cases where other approaches have failed. Surgery may be needed to remove a kidney stone if it

- does not pass after a reasonable period of time and causes constant pain
- is too large to pass on its own or is caught in a difficult place
- blocks the flow of urine
- causes ongoing urinary tract infection
- damages kidney tissue or causes constant bleeding
- has grown larger (as seen on followup x ray studies).

Until 20 years ago, surgery was necessary to remove a stone. It was very painful and required a recovery time of 4 to 6 weeks. Today, treatment for these stones is greatly improved, and many options do not require major surgery.

Extracorporeal Shockwave Lithotripsy

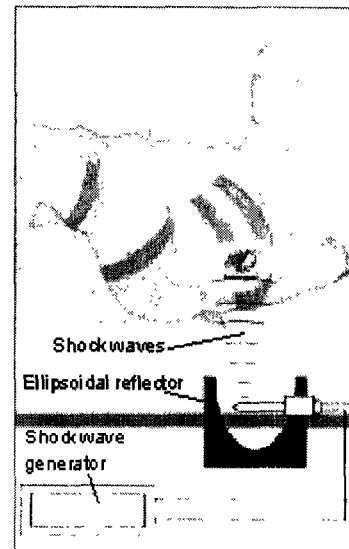
Extracorporeal shockwave lithotripsy (ESWL) is the most frequently used procedure for the treatment of kidney stones. In ESWL, shock waves that are created outside the body travel through the skin and body tissues until they hit the denser stones. The stones break down into sand-like particles and are easily passed through the urinary tract in the urine.

There are several types of ESWL devices. In one device, the patient reclines in a water bath while the shock waves are transmitted. Other devices have a soft cushion on which the patient lies. Most devices use either x rays or ultrasound to help the

surgeon pinpoint the stone during treatment. For most types of ESWL procedures, anesthesia is needed.

In most cases, ESWL may be done on an outpatient basis. Recovery time is short, and most people can resume normal activities in a few days.

Complications may occur with ESWL. Most patients have blood in their urine for a few days after treatment. Bruising and minor discomfort in the back or abdomen from the shock waves are also common. To reduce the risk of complications, doctors usually tell patients to avoid taking aspirin and other drugs that affect blood clotting for several weeks before treatment.



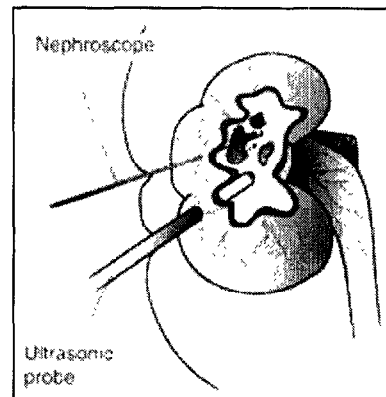
Extracorporeal shockwave lithotripsy

Another complication may occur if the shattered stone particles cause discomfort as they pass through the urinary tract. In some cases, the doctor will insert a small tube called a stent through the bladder into the ureter to help the fragments pass. Sometimes the stone is not completely shattered with one treatment, and additional treatments may be needed. ESWL is not ideal for very large stones.

Percutaneous Nephrolithotomy

Sometimes a procedure called percutaneous nephrolithotomy is recommended to remove a stone. This treatment is often used when the stone is quite large or in a location that does not allow effective use of ESWL.

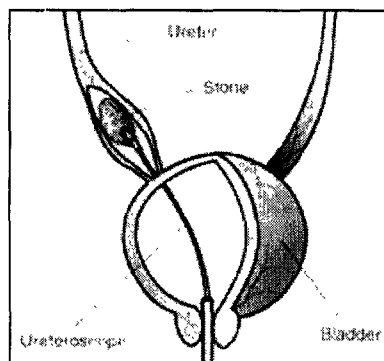
In this procedure, the surgeon makes a tiny incision in the back and creates a tunnel directly into the kidney. Using an instrument called a nephroscope, the surgeon locates and removes the stone. For large stones, some type of energy probe (ultrasonic or electrohydraulic) may be needed to break the stone into small pieces. Generally, patients stay in the hospital for several days and may have a small tube called a nephrostomy tube left in the kidney during the healing process.



Percutaneous nephrolithotomy

One advantage of percutaneous nephrolithotomy over ESWL is that the surgeon removes the stone fragments instead of relying on their natural passage from the kidney.

Ureteroscopic Stone Removal



Ureteroscopic stone removal

Although some kidney stones in the ureters can be treated with ESWL, ureteroscopy may be needed for mid- and lower-ureter stones. No incision is made in this procedure. Instead, the surgeon passes a small fiberoptic instrument called a ureteroscope through the urethra and bladder into the ureter. The surgeon then locates the stone and either removes it with a cage-like device or shatters it with a special instrument that produces a form of shock wave. A small tube or stent may be left in the ureter for a few days to help the lining of the ureter heal. Before fiber optics made ureteroscopy possible, physicians used a similar "blind basket" extraction method. But this outdated technique should not be used because it may damage the ureters.

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Hope Through Research

The Division of Kidney, Urologic, and Hematologic Diseases of the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) funds research on the causes, treatments, and prevention of kidney stones. NIDDK is part of the Federal Government's National Institutes of Health in Bethesda, Maryland.

New drugs and the growing field of lithotripsy have greatly improved the treatment of kidney stones. Still, NIDDK researchers and grantees seek to answer questions such as

- Why do some people continue to have painful stones?
- How can doctors predict, or screen, those at risk for getting stones?
- What are the long-term effects of lithotripsy?
- Do genes play a role in stone formation?

- What is the natural substance(s) found in urine that blocks stone formation?

Researchers are also working on new drugs with fewer side effects.

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Prevention Points to Remember

- If you have a family history of stones or have had more than one stone, you are likely to develop more stones.
- A good first step to prevent the formation of any type of stone is to drink plenty of liquids—water is best.
- If you are at risk for developing stones, your doctor may perform certain blood and urine tests to determine which factors can best be altered to reduce that risk.
- Some people will need medicines to prevent stones from forming.
- People with chronic urinary tract infections and stones will often need the stone removed if the doctor determines that the infection results from the stone's presence. Patients must receive careful followup to be sure that the infection has cleared.

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For More Information

American Foundation for Urologic Disease

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Email: admin@afud.org
Internet: www.afud.org

American Urological Association

1000 Corporate Boulevard
Linthicum, MD 21090
Phone: 1-866-RING-AUA (746-4282) or 410-689-3700
Fax: 410-689-3800
Email: aua@auanet.org
Internet: www.urologyhealth.org

National Kidney Foundation

30 East 33rd Street
New York, NY 10016
Phone: 1-800-622-9010 or 212-889-2210
Email: info@kidney.org
Internet: www.kidney.org

Oxalosis and Hyperoxaluria Foundation (OHF)

201 East 19th Street, #12E
New York, NY 10003
Phone: 1-800-OHF-8699 (643-8699) or 212-777-0470
Fax: 212-777-0471
Email: execdirector@ohf.org
Internet: www.ohf.org

For Information About Hyperparathyroidism:

National Institute of Diabetes and Digestive and Kidney Diseases

Building 31, Room 9A04
31 Center Drive MSC-2560
Bethesda, MD 20892
Phone: 301-496-3583
Internet: www.niddk.nih.gov

For Information About Gout:

National Institute of Arthritis and Musculoskeletal and Skin Diseases Information Clearinghouse

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Bethesda, MD 20892-3675
Phone: 1-877-22-NIAMS (226-4267) or 301-495-4484
TTY: 301-565-2966
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Publications produced by the clearinghouse are carefully reviewed by both NIDDK scientists and outside experts. This fact sheet was reviewed by Frederic L. Coe., M.D., University of Chicago.

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