Kidney Stones in Children

National Kidney and Urologic Diseases Information Clearinghouse

U.S. Department of Health and Human Services

NATIONAL INSTITUTES OF HEALTH

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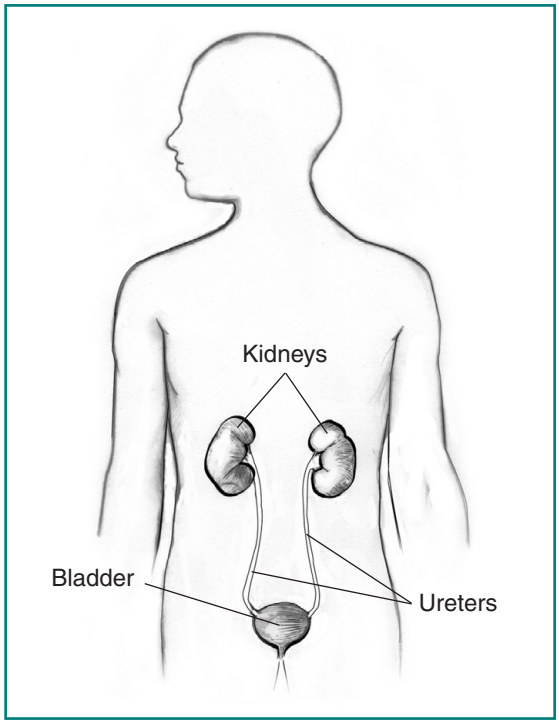
What is a kidney stone?

A kidney stone is a solid piece of material that forms in a kidney when substances that are normally found in the urine become highly concentrated. A stone may stay in the kidney or travel down the urinary tract. Kidney stones vary in size. A small stone may pass out of the body causing little or no pain. A larger stone may get stuck along the urinary tract and can block the flow of urine, causing severe pain or blood that can be seen in the urine.

What is the urinary tract?

The urinary tract is the body's drainage system for removing wastes and extra water. The urinary tract includes two kidneys, two ureters, a bladder, and a urethra. The kidneys are a pair of bean-shaped organs, each about the size of a fist and located below the ribs, one on each side of the spine, toward the middle of the back. Every minute, a person's kidneys filter about 3 ounces of blood, removing wastes and extra water. The wastes and extra water make up the 1 to 2 quarts of urine an adult produces each day. Children produce less urine each day; the amount produced depends on their age. The urine travels from the kidneys down two narrow tubes called the ureters. The urine is then stored in a balloonlike organ called the bladder. When the bladder empties, urine flows out of the body through a tube called the urethra at the bottom of the bladder.



The kidneys remove wastes and extra water from the blood to form urine. Urine travels from the kidneys to the bladder through the ureters.

Are kidney stones common in children?

No exact information about the incidence of kidney stones in children is available, but many kidney specialists report seeing more children with this condition in recent years. While kidney stones are more common in adults, they do occur in infants, children, and teenagers from all races and ethnicities.

What causes kidney stones in children?

Kidney stones can form when substances in the urine—such as calcium, magnesium, oxalate, and phosphorous—become highly concentrated due to one or more causes:

- Defects in the urinary tract may block the flow of urine and create pools of urine. In stagnant urine, stone-forming substances tend to settle together into stones. Up to one-third of children who have stones have an anatomic abnormality in their urinary tract.
- Kidney stones may have a genetic cause. In other words, the tendency to form stones can run in families due to inherited factors.
- An unhealthy lifestyle may make children more likely to have kidney stones. For example, drinking too little water or drinking the wrong types of fluids, such as soft drinks or drinks with caffeine, may cause substances in the urine to become too concentrated. Similarly, too much sodium, or salt, in the diet may contribute to more chemicals in the urine, causing an increase in stone formation. Some doctors believe increases in obesity rates, less active lifestyles, and diets higher in salt may be causing more children to have kidney stones.
- Sometimes, a urinary tract infection can cause kidney stones to form. Some types of bacteria in the urinary tract break down urea—a waste product removed from the blood by the kidneys—into substances that form stones.
- Some children have metabolic disorders that lead to kidney stones. Metabolism is the way the body uses digested food for energy, including the process of breaking down food, using food's nutrients in the body, and removing the wastes that remain. The most common metabolic disorder that causes kidney stones in children is hypercalciuria, which causes extra calcium to collect in the urine. Other more rare metabolic conditions involve problems breaking down oxalate, a substance made in the body and found in some foods. These conditions include hyperoxaluria, too much oxalate in the urine, and oxalosis, characterized by deposits of oxalate and calcium in the body's tissues. Another rare metabolic condition called cystinuria can cause kidney stones. Cystinuria is an excess of the amino acid cystine in the urine. Amino acids are the building blocks of proteins.

What are the signs and symptoms of kidney stones in children?

Children with kidney stones may have pain while urinating, see blood in the urine, or feel a sharp pain in the back or lower abdomen. The pain may last for a short or long time. Children may experience nausea and vomiting with the pain. However, children who have small stones that pass easily through the urinary tract may not have symptoms at all.

What types of kidney stones occur in children?

Four major types of kidney stones occur in children:

- **Calcium stones** are the most common type of kidney stone and occur in two major forms: **calcium oxalate** and **calcium phosphate.** Calcium oxalate stones are more common. Calcium oxalate stone formation has various causes, which may include high calcium excretion, high oxalate excretion, or acidic urine. Calcium phosphate stones are caused by alkaline urine.
- **Uric acid stones** form when the urine is persistently acidic. A diet rich in purines—substances found in animal proteins such as meats, fish, and shellfish—may cause uric acid. If uric acid becomes concentrated in the urine, it can settle and form a stone by itself or along with calcium.
- **Struvite stones** result from kidney infections. Eliminating infected stones from the urinary tract and staying infection-free can prevent more struvite stones.
- **Cystine stones** result from a genetic disorder that causes cystine to leak through the kidneys and into the urine in high concentration, forming crystals that tend to accumulate into stones.

How are kidney stones in children diagnosed?

The process of diagnosing any illness begins with consideration of the symptoms. Pain or bloody urine may be the first symptom. Urine, blood, and imaging tests will help determine whether symptoms are caused by a stone. Urine tests can be used to check for infection and for substances that form stones. Blood tests can be used to check for biochemical problems that can lead to kidney stones. Various imaging techniques can be used to locate the stone:

- **Ultrasound** uses a device, called a transducer, that bounces safe, painless sound waves off organs to create an image of their structure. An abdominal ultrasound can create images of the entire urinary tract. The procedure is performed in a health care provider's office, outpatient center, or hospital by a specially trained technician, and the images are interpreted by a radiologist—a doctor who specializes in medical imaging; anesthesia is not needed. The images can show the location of any stones. This test does not expose children to radiation, unlike some other imaging tests. Although other tests are more useful in detecting very small stones or stones in the lower portion of the ureter, ultrasound is considered by many health care providers to be the best screening test to look for stones.
- **Computerized tomography (CT) scans** use a combination of x rays and computer technology to create three-dimensional (3-D) images. A CT scan may include the injection of a special dye, called contrast medium. CT scans require the child to lie on a table that slides into a tunnel-shaped device where the x rays are taken. The procedure is performed in an outpatient center or hospital by an x-ray technician, and the images are interpreted by a radiologist; anesthesia is not needed. CT scans may be required to get an accurate stone count when children are being considered for urologic surgery. Because CT scans expose children to a moderate amount of radiation, health care providers try to reduce radiation exposure in

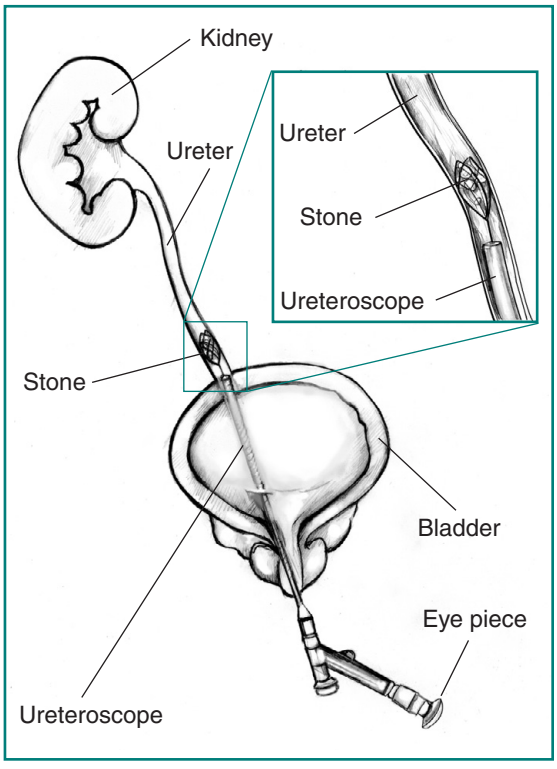
children by avoiding repeated CT scans, restricting the area scanned as much as possible, and using the lowest radiation dose that will provide the needed diagnostic information.

- **X-ray** machines use radiation to create images of the child's urinary tract. The images can be taken at an outpatient center or hospital by an x-ray technician, and the images are interpreted by a radiologist; anesthesia is not needed. The x rays are used to locate many kinds of stones. A conventional x ray is generally less informative than an ultrasound or CT scan, but it is less expensive and can be done more quickly than other imaging procedures.

How are kidney stones in children treated?

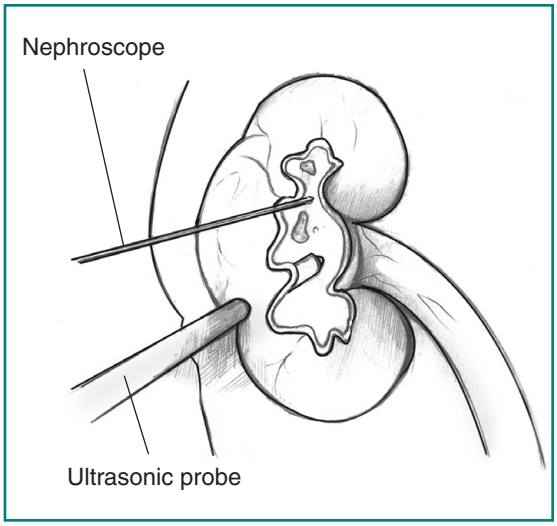
The treatment for a kidney stone usually depends on its size and what it is made of, as well as whether it is causing symptoms of pain or obstructing the urinary tract. Small stones usually pass through the urinary tract without treatment. Still, children will often require pain control and encouragement to drink lots of fluids to help move the stone along. Pain control may consist of oral or intravenous (IV) medication, depending on the duration and severity of the pain. IV fluids may be needed if the child becomes dehydrated from vomiting or an inability to drink. A child with a larger stone, or one that blocks urine flow and causes great pain, may need to be hospitalized for more urgent treatment. Hospital treatments may include the following:

- **Shock wave lithotripsy (SWL).** A machine called a lithotripter is used by the doctor to crush the kidney stone. In SWL, the child lies on a table or, less commonly, in a tub of water above the lithotripter. The lithotripter generates shock waves that pass through the child's body to break the kidney stone into smaller particles to pass more readily through the urinary tract. Children younger than age 12 may receive general anesthesia during the procedure. Older children usually receive an IV sedative and pain medication.
- **Removal of the stone with a ureteroscope.** A ureteroscope is a long, tube-like instrument used to visualize the urinary tract. After the child receives a sedative, the doctor inserts the ureteroscope into the child's urethra and slides the scope through the bladder and into the ureter. Through the ureteroscope, which has a small basket attached to the end, the doctor may be able to see and remove the stone in the ureter.

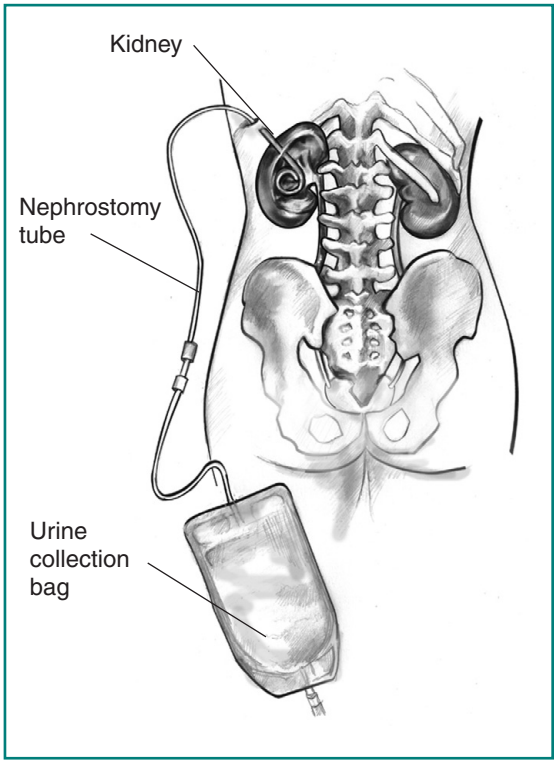


Ureteroscopic stone removal

- **Lithotripsy with a ureteroscope.** Another way to treat a kidney stone through a ureteroscope is to extend a flexible fiber through the scope up to the stone. The fiber is attached to a laser generator. Instead of shock waves, the fiber delivers a laser beam to break the stone into smaller pieces that can pass out of the body in the urine. The child may receive general anesthesia or IV sedation.
- **Percutaneous nephrolithotomy.** In this procedure, a tube is inserted directly into the kidney through an incision in the child's back. Using a wire-thin viewing instrument called a nephroscope, the doctor locates and removes the stone. For large stones, an ultrasonic probe that acts as a lithotripter may be needed to deliver shock waves that break the stone into small pieces that can be removed more easily. Children receive general anesthesia for percutaneous nephrolithotomy. Often, children stay in the hospital for several days after the procedure and may have a small tube called a nephrostomy tube inserted through the skin into the kidney. The nephrostomy tube drains urine and any residual stone fragments from the kidney into a urine collection bag. The tube usually is left in the kidney for 2 or 3 days while the child remains in the hospital.



Percutaneous nephrolithotomy



Nephrostomy tube

How are kidney stones in children prevented?

To prevent kidney stones, health care providers and their patients must understand what is causing the stones to form. Especially in children with suspected metabolic abnormalities or with recurrent stones, a 24-hour urine collection is obtained to measure daily urine volume and to determine if any underlying mineral abnormality is making a child more likely to form stones. Based on the analysis of the collected urine, the treatment can be individualized to address a metabolic problem.

In all circumstances, children should drink plenty of fluids to keep the urine diluted and flush away substances that could form kidney stones. Urine should be almost clear.

Eating, Diet, and Nutrition

Families may benefit from meeting with a dietitian to learn how dietary management can help in preventing stones. Depending on the underlying cause of the stone formation, medications may be necessary to prevent recurrent stones. Dietary changes and medications may be required for a long term or, quite often, for life. Some common changes include the following:

- Children who tend to make calcium oxalate stones or have hypercalciuria should eat a regular amount of dietary calcium and limit salt intake. A thiazide diuretic medication may be given to some children to reduce the amount of calcium leaking into the urine.
- Children who have large amounts of oxalate in the urine may need to limit foods high in oxalate, such as chocolate, peanut butter, and dark-colored soft drinks.
- Children who form uric acid or cystine stones may need extra potassium citrate or potassium carbonate in the form of a pill or liquid medication. Avoiding foods high in purines—such as meat, fish, and shellfish—may also help prevent uric acid stones.

Points to Remember

- A kidney stone is a solid piece of material that forms in a kidney when some substances that are normally found in the urine become highly concentrated.
- Kidney stones occur in infants, children, and teenagers from all races and ethnicities.
- Kidney stones in children are diagnosed using a combination of urine, blood, and imaging tests.
- The treatment for a kidney stone usually depends on its size and composition as well as whether it is causing symptoms of pain or obstructing the urinary tract.
- Small stones usually pass through the urinary tract without treatment. Still, children will often require pain control and encouragement to drink lots of fluids to help move the stone along.
- Children with larger stones, or stones that block urine flow and cause great pain, may need to be hospitalized for more urgent treatment.
- Hospital treatments may include shock wave lithotripsy (SWL), removal of the stone with a ureteroscope, lithotripsy with a ureteroscope, or percutaneous nephrolithotomy.
- To prevent recurrent kidney stones, health care providers and their patients must understand what is causing the stones to form.
- In all circumstances, children should drink plenty of fluids to keep the urine diluted and flush away substances that could form kidney stones. Urine should be almost clear.

Hope through Research

The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), one of the National Institutes of Health, supports research aimed at better understanding and preventing kidney stones in children. Researchers supported by the NIDDK have identified three proteins that inhibit the formation of calcium oxalate stones. Conventional urine tests do not provide information about the presence or absence of these proteins. Developing a test for these proteins that can be used in the clinical setting will help health care providers identify children at risk for stone formation so they can manage that risk.

Participants in clinical trials can play a more active role in their own health care, gain access to new research treatments before they are widely available, and help others by contributing to medical research. For information about current studies, visit *www.ClinicalTrials.gov.*

You may also find additional information about this topic by visiting MedlinePlus at *www.medlineplus.gov.*

This publication may contain information about medications. When prepared, this publication included the most current information available. For updates or for questions about any medications, contact the U.S. Food and Drug Administration toll-free at 1–888–INFO–FDA (1–888–463–6332) or visit *www.fda.gov.* Consult your health care provider for more information.

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Acknowledgments

Publications produced by the Clearinghouse are carefully reviewed by both NIDDK scientists and outside experts. This publication was reviewed by the following members of the American Society of Pediatric Nephrology Clinical Affairs Committee: Michael Somers, M.D., Children's Hospital Boston; Deepa Chand, M.D., M.H.S.A., Akron Children's Hospital; John Foreman, M.D., Duke University; Jeffrey Fadrowski, M.D., M.H.S., The Johns Hopkins University; Kevin Meyers, M.D., Children's Hospital of Philadelphia; Greg Nelsen, M.S.S.W., University of Virginia Health System; Michelle Baum, M.D., Children's Hospital Boston; and Ann Guillot, M.D., University of Vermont.

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
National Institutes of Health

NIH Publication No. 11–7383
September 2011