

Imaging of the Urinary Tract

National Kidney and Urologic Diseases Information Clearinghouse



National
Institute of
Diabetes and
Digestive
and Kidney
Diseases

NATIONAL
INSTITUTES
OF HEALTH

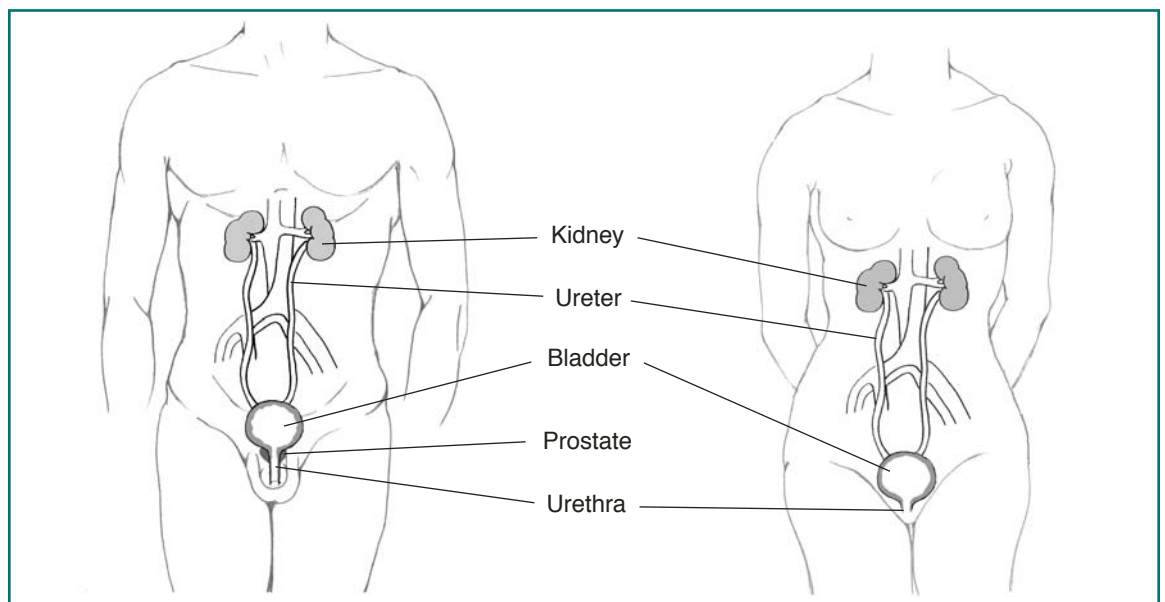
What does “imaging” mean?

In medicine, “imaging” is the general term for any technique used to provide pictures of bones and organs inside the body. Imaging techniques consist of x rays, ultrasound, magnetic resonance imaging (MRI), and computerized tomography (CT) scans. Imaging helps doctors see the causes of medical problems.

What is the urinary tract?

The urinary tract consists of the organs, tubes, and muscles that work together to make, move, store, and release urine, the liquid waste of the human body. The upper urinary tract includes the kidneys,

which filter wastes and extra fluid from the blood, and the ureters, which carry urine from the kidneys to the bladder. The lower urinary tract includes the bladder, a balloon-shaped muscle that stores urine, and the urethra, a tube that carries urine from the bladder to the outside of the body during urination. Doctors who specialize in kidney problems are called nephrologists. Doctors who specialize in problems of the organs and tubes that transport urine from the kidneys to outside the body are called urologists. These problems may involve cancers or growths of these organs, including the kidneys, ureters, bladder, and testes, or may involve abnormalities in storing or releasing urine.



Male and female urinary tracts.



U.S. Department
of Health and
Human Services

What problems could require imaging of the urinary tract?

Imaging may help your doctor find the cause of

- urinary incontinence—unintended leakage of urine
- frequent, urgent urination
- blockage of urine
- abdominal mass
- pain in the groin or lower back
- blood in the urine
- high blood pressure
- kidney failure

One symptom could have several possible causes. Your doctor can use imaging techniques to determine, for example, whether a urinary stone or an enlarged prostate is blocking urine flow. Imaging can also help clarify kidney diseases, tumors, urinary reflux—backward flow of urine—urinary tract infections, incomplete emptying, and small bladder capacity.

What factors will my doctor consider before ordering tests?

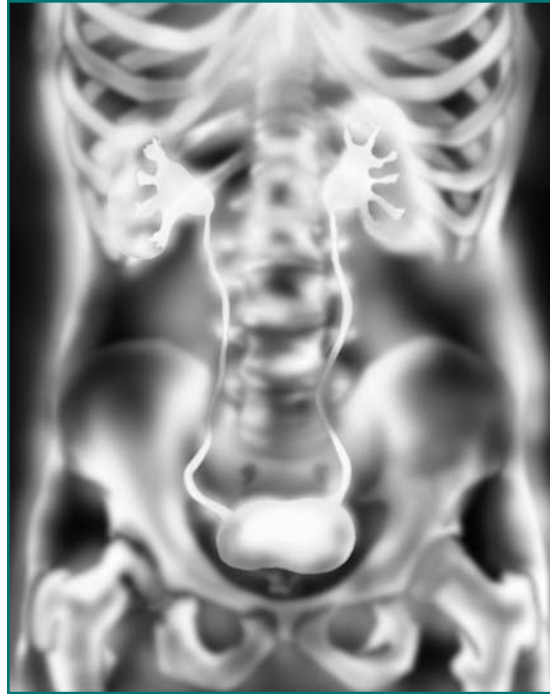
The first step in solving a urinary problem is to talk with your doctor. You will be asked about your general medical history, including any major illnesses or surgeries, so you should be prepared to give as many details as you can about the problem and when it started. You should mention all the medicines you take, both prescription and nonprescription, because they might be part of the problem. You should also talk about how much fluid you drink a day and whether the beverages you drink contain alcohol or caffeine.

Why does the doctor choose one imaging technique instead of another?

Your doctor will look at several factors to decide what imaging technique to use. Each has advantages and disadvantages. Convenience and cost-effectiveness are also factors.

Conventional radiology. Doctors have used x-ray machines to diagnose diseases for about a century. X rays of the urinary tract can help highlight a kidney stone or tumor that could block the flow of urine and cause pain. An x ray can also show the size and shape of the prostate. Conventional x rays do involve some exposure to ionizing radiation—radiation that is strong enough to damage some cells. Two x-ray procedures involve the use of contrast medium, which is a liquid that acts like a dye and shows the shape of the urinary tract as it passes through the tract.

- *Intravenous pyelogram (IVP)*—In an IVP, the contrast medium is injected into a vein, usually in the arm. The radiologist takes a series of snapshots as the medium circulates through the blood and reaches the kidneys. The structure of the kidneys shows up clearly on the x rays as the contrast medium is filtered from the blood and passes through the kidneys to the ureters.
- *Voiding cystourethrogram (VCUG)*—In a VCUG, a catheter inserted in the urethra is used to fill the bladder with the contrast medium. The x-ray machine then captures a video of the contrast medium during urination. This procedure allows the doctor to see things such as whether urine is backing up into the ureters when it should be traveling the other way,



Intravenous pyelogram (IVP).

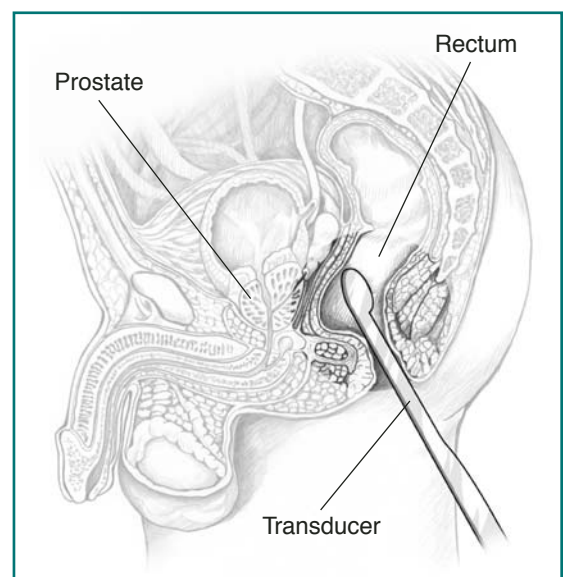
down through the urethra, or whether urine outflow through the urethra is blocked. VCUG is often used with children who have recurrent infections to determine whether a defect in the urinary tract is causing the infections. It can also show blockages from an enlarged prostate in men or abnormal bladder position in women.

Ultrasound. In ultrasound, or sonography, a technician holds a device, called a transducer, that sends harmless sound waves into the body and catches them as they bounce back off the internal organs to create a picture on a monitor. Different angles make it possible to examine different organs.

- *Abdominal ultrasound*—In abdominal ultrasound, the technician applies a gel to the patient's abdomen and holds the transducer against the skin. The gel

allows the transducer to glide easily, and it improves the transmission of the signals. Abdominal ultrasounds are well known for taking pictures of fetuses in the womb and of a woman's ovaries and uterus, but this approach can also be used to evaluate the size and shape of the kidneys.

- *Transrectal ultrasound*—Transrectal ultrasound is most often used to examine the prostate. The transducer is inserted into the patient's rectum so that it is right next to the prostate. The ultrasound image shows the size and shape of the prostate and any irregularity that might be a tumor. To determine whether an abnormal-looking area is in fact a tumor, the doctor can use the transducer and the ultrasound images to guide a biopsy needle to the suspected tumor. The needle collects a few pieces of prostate tissue for examination with a microscope.

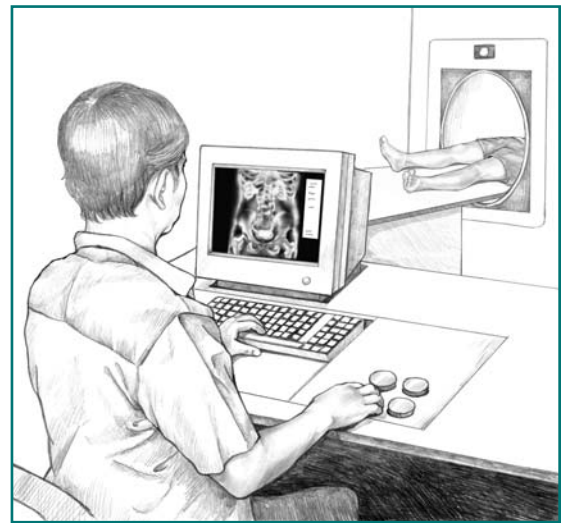


Transrectal ultrasound.

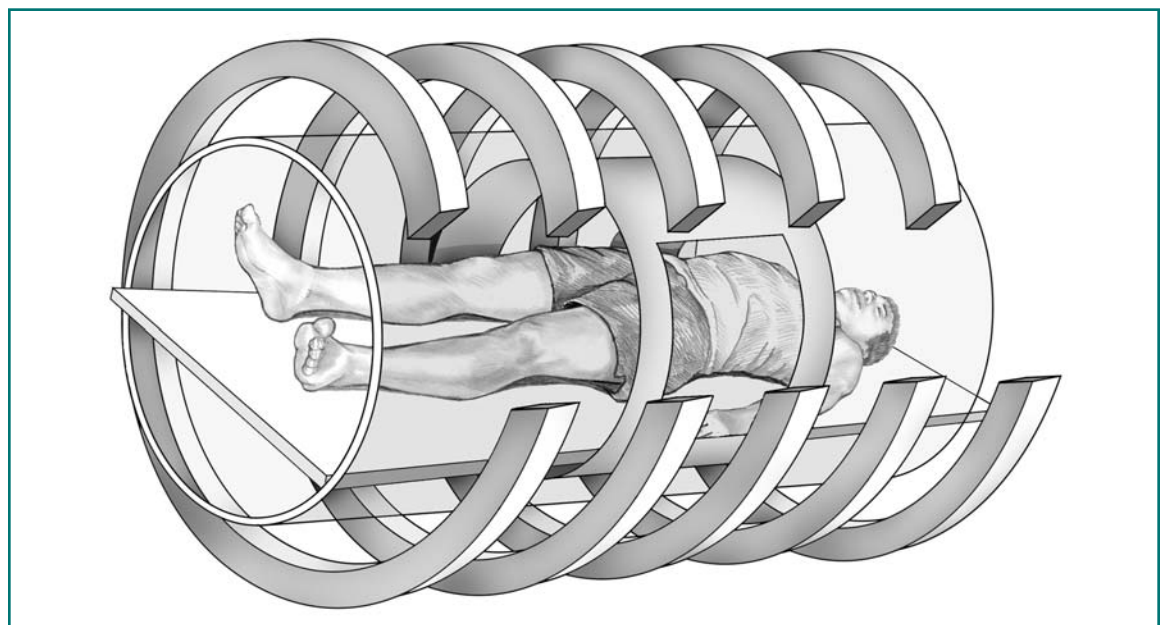
MRI. MRI machines use radio waves and magnets to produce detailed pictures of internal organs and tissues. No exposure to radiation occurs. With most MRI machines, the patient lies on a table that slides into a tunnel that may be open-ended or closed at one end. Some newer machines are designed to allow the patient to lie in a more open space. During an MRI, the patient is awake but must remain perfectly still while the images are being taken, usually only a few minutes. A sequence of images may be needed to create a detailed picture of the organ. During the sequencing, the patient will hear mechanical knocking and humming noises.

- *Magnetic resonance angiogram (MRA)*—An MRA provides the most detailed view of renal arteries. It can show renal artery stenosis, which is a narrowing of vessels that causes poor blood flow to the kidney and can cause high blood pressure and lead to reduced kidney function and eventually to kidney failure.

CT scan. CT scans use a combination of x rays and computer technology to create three-dimensional images. Like MRIs, CT scans require the patient to lie on a table that slides into a tunnel. CT scans can help identify stones in the urinary tract, infections, cysts, tumors, and traumatic injury to the kidneys and ureters.



CT scan.



Magnetic resonance angiogram (MRA).

How do I prepare for an imaging examination?

How you prepare will depend on the purpose of the examination and the type of equipment to be used. You should listen to your doctor's instructions carefully and ask questions if you do not understand something that is said.

- Your doctor needs to know if you have any allergies to foods or medications and if you have had any recent illnesses or medical conditions.
- Your doctor may tell you not to eat or drink anything for 12 hours before the test. For some ultrasound examinations, however, you may be instructed to drink several glasses of water 2 hours before the examination so your bladder will be full.
- You may be given a laxative to clear the colon before the examination. If you are having a transrectal ultrasound, you will be given an enema about 4 hours before the examination.
- If you are having an MRI or MRA, talk with the technical staff about any implanted devices—such as heart pacemakers, intrauterine devices (IUDs), hip replacements, and implanted ports for catheterization—that may have metal parts that will affect the images. Metal plates, pins, screws, and surgical staples, as well as any bullets or shrapnel you might have in your body, may cause a problem if they have been in place for less than 4 to 6 weeks.
- If you feel uneasy in enclosed spaces, you may need to have a sedative before an MRI or a CT scan.

What are the test procedures like?

Most procedures for imaging the urinary tract are performed as the patient lies on a table.

- For an IVP, dye is injected into a vein, and x-ray pictures are taken at 0, 5, 10, and 15 minutes to see the progression of the contrast medium through the kidneys and ureters. The dye makes the kidneys and urine visible on the x ray and shows any narrowing or blockage in the urinary tract. This procedure can help identify problems in the kidneys, ureters, or bladder that may have resulted from urine retention or backup.
- MRI and CT scans may also require injection of dye. You will be asked to lie still for minutes at a time as the equipment takes pictures from different angles. A computer puts the different views together to create a three-dimensional model of your urinary tract. Some patients find it uncomfortable to lie in the small imaging tunnel, and others find the equipment noises annoying or unsettling. Knowing what to expect helps make these aspects of the test less disturbing.
- VCUG is most often used to evaluate urinary problems in children. The doctor or nurse cleans the area around the urethra, inserts the tip of the catheter, and gently slides it up into the bladder. The child's bladder is first emptied. Contrast medium is slowly dripped into the bladder, by means of gravity, until the bladder is full. X-ray films are then made as the child urinates.

- For a transrectal ultrasound, the doctor or technician inserts a probe slightly larger than a pen into the rectum. The probe directs high-frequency sound waves at the prostate and the echo patterns form an image of the gland on a monitor. Although the image shows the size of the prostate and any irregularities, it cannot definitively identify tumors. To determine whether an abnormal-looking area is in fact a tumor, the doctor can use the probe and the ultrasound images to guide a biopsy needle to the area. The needle collects a few pieces of prostate tissue for examination with a microscope.
- For an abdominal ultrasound exam, a technician will apply gel to your abdomen and sweep a handheld transducer across the area to generate a picture of your urinary tract. Like the IVP, an abdominal ultrasound can show damage or abnormalities in the upper urinary tract.

What should I do after the test?

For most of these tests, you will be able to resume normal activity immediately afterward. If your test involved placing a catheter in the urethra, you may have some mild discomfort. Drinking an 8-ounce glass of water every 30 minutes for 2 hours should help. Also, you may be able to take a warm bath. Alternatively, holding a warm, damp washcloth over the urethral opening may relieve the discomfort.

You may experience some discomfort after a transrectal ultrasound as well. A prostate biopsy may produce pain in the rectum and the perineum—the area between the rectum and the scrotum.

For catheterization or biopsy, your doctor will sometimes, but not always, give you an antibiotic to take for 1 or 2 days to prevent an infection. If you notice signs of infection—including chills, fever, or persistent pain when you urinate—you should call your doctor at once.

When will I get the results?

Results for simple tests can be discussed with your doctor or nurse immediately after the test. Other results may take a few days. You will have the chance to ask questions about the results and possible treatments for your problem.

Hope Through Research

The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) has many research programs aimed at understanding kidney and urologic disorders, including urinary stones, enlarged prostate, urinary incontinence, and kidney failure. The NIDDK has established a program to develop and test accurate, reproducible techniques to monitor the progression of polycystic kidney disease so that potential interventions can be evaluated. This program will apply the latest advances in imaging technology so that clinicians can use information about kidney size and the portion of the kidney occupied by cysts to determine how far the disease has progressed. For example, current state-of-the-art methods using MRI techniques with rapid image acquisition rates make possible high-resolution, three-dimensional images of the kidneys. Semiautomated image analysis can determine renal size and the location of cystic structures. MRI may also permit simultaneous estimation of kidney function.

For More Information

American Urological Association Foundation

1000 Corporate Boulevard
Suite 410

Linthicum, MD 21090

Phone: 1-866-RING-AUA (746-4282)
or 410-689-3700

Email: patienteducation@auafoundation.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

Internet: www.kidney.org

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

National Kidney and Urologic Diseases Information Clearinghouse

3 Information Way
Bethesda, MD 20892-3580
Phone: 1-800-891-5390
Fax: 703-738-4929
Email: nkudic@info.niddk.nih.gov
Internet: www.kidney.niddk.nih.gov

The National Kidney and Urologic Diseases Information Clearinghouse (NKUDIC) is a service of the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). The NIDDK is part of the National Institutes of Health of the U.S. Department of Health and Human Services. Established in 1987, the Clearinghouse provides information about diseases of the kidneys and urologic system to people with kidney and urologic disorders and to their families, health care professionals, and the public. The NKUDIC answers inquiries, develops and distributes publications, and works closely with professional and patient organizations and Government agencies to coordinate resources about kidney and urologic diseases.

Publications produced by the Clearinghouse are carefully reviewed by both NIDDK scientists and outside experts. This fact sheet was reviewed by Linda M. Dairiki Shortliffe, M.D., Stanford University Medical Center; and Vicente E. Torres, M.D., Mayo Clinic, Rochester.

This publication is not copyrighted. The Clearinghouse encourages users of this fact sheet to duplicate and distribute as many copies as desired.

This fact sheet is also available at
www.kidney.niddk.nih.gov.



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

NIH Publication No. 07-5107
November 2006