



## Urography

Urography uses imaging and contrast material to evaluate or detect blood in urine, kidney or bladder stones, and cancer in the urinary tract. Urography with conventional x-ray is known as intravenous pyelogram (IVP). Urography is also often performed using computed tomography (CT) or magnetic resonance imaging (MRI). CT and MR urography are painless and proven effective in detecting urinary tract issues.



Your preparation may vary depending on whether your exam will use CT or MRI. Tell your doctor if there's a possibility you are pregnant and discuss any recent illnesses, medical conditions, medications you're taking, and allergies – especially to contrast materials. Your doctor may instruct you to not eat or drink anything several hours beforehand. In order to distend your urinary bladder, you may be asked to drink water prior to the exam and not to urinate until your scan is complete. Leave jewelry at home and wear loose, comfortable clothing. You may be asked to wear a gown.

## What is Urography?

Urography is an examination used to evaluate the kidneys, ureters and bladder. Excretory urography, also known as intravenous pyelogram, is performed using conventional x-ray after the intravenous administration of radiographic contrast material. This technique is still performed for pediatric patients and occasionally for younger adult patients.

Computed tomography (CT) urography and magnetic resonance (MR) urography use CT and MR images, respectively, after intravenous contrast material to obtain images of the urinary tract. CT urography (CTU) and MR urography (MRU) are used as primary imaging techniques to evaluate patients with blood in the urine (hematuria), follow patients with prior history of cancers of the urinary collecting system and to identify abnormalities in patients with recurrent urinary tract infections. In addition to imaging the urinary tract, CT and MR urography can provide valuable information about other abdominal and pelvic structures and diseases that may affect them.

## What are some common uses of the procedure?

Urography images are used to evaluate issues or detect abnormalities in portions of the urinary tract, including the kidneys, bladder and ureters, including:

- Hematuria (blood in urine)
- Kidney or bladder stones
- Cancers of the urinary tract

## How should I prepare?

### CT Urography

If your physician has ordered a CT urography exam, you should wear comfortable, loose-fitting clothing to your exam. You may be given a gown to wear during the procedure.

Metal objects including jewelry, eyeglasses, dentures and hairpins may affect the CT images and should be left at home or removed prior to your exam. You may also be asked to remove hearing aids and removable dental work. Women will be asked to remove bras containing metal underwire. In order to distend your urinary bladder, you may be asked to drink water prior to the examination, and also not to urinate until after the scan is complete. However, guidelines about eating and drinking before a CT exam vary with the specific exam and also with the facility.

You may be asked not to eat or drink anything for several hours before the exam, especially if a contrast material will be used. You should inform your physician of any medications you are taking and if you have any allergies. If you have a known allergy to contrast material, or "dye," inform your doctor. Based on your allergic history, your doctor may decide to provide medications to reduce the risk of allergic reaction or decide to cancel your exam.

Also, inform your doctor of any recent illnesses or other medical conditions, and if you have a history of heart disease (particularly congestive heart failure or hypertension), asthma, diabetes, kidney disease, prior organ transplantation, use of chronic NSAIDs (e.g., Motrin), anti-rejection medication or certain antibiotics. Any of these conditions or medications may increase the risk of an unusual adverse effect following the administration of contrast for CT urography.

Women should always inform their physician and the CT technologist if there is any possibility that they are pregnant. See the Safety page for more information about pregnancy and x-rays.

### MR Urography

If you are scheduled for an MR urography exam, you may be asked to wear a gown during the exam or you may be allowed to wear your own clothing if it is loose-fitting and has no metal fasteners.

In order to distend your urinary bladder, you may be asked to drink water prior to the examination, and also not to urinate until after the scan is complete. However, guidelines about eating and drinking before an MRI exam vary with the specific exam and also with the facility. For some types of exams, you will be

asked to fast for eight to 12 hours. Unless you are told otherwise, you may follow your regular daily routine and take medications as usual.

If you are scheduled to undergo MR urography, you may have contrast material injected intravenously for the exam. The radiologist or technologist may ask if you have asthma or allergies of any kind, such as an allergy to gadolinium drugs, certain foods or the environment.

The radiologist should also know if you have any serious health problems or if you have recently had surgery. Some conditions, such as severe kidney disease, may prevent you from being given gadolinium for an MRI. If there is a history of severe kidney disease, it may be necessary to perform a blood test to determine whether the kidneys are functioning adequately.

Women should always inform their physician or technologist if there is any possibility that they are pregnant. MRI has been used for scanning patients since the 1980s with no reports of any ill effects on pregnant women or their unborn babies. However, because the unborn baby will be in a strong magnetic field, pregnant women should not have this exam in the first three to four months of pregnancy unless the potential benefit from the MRI exam is assumed to outweigh the potential risks. Pregnant women should not receive injections of gadolinium contrast material except when absolutely necessary for medical treatment. See the MRI Safety page for more information about pregnancy and MRI.

If you have claustrophobia (fear of enclosed spaces) or anxiety, you may want to ask your physician for a prescription for a mild sedative prior to your scheduled examination.

With advance notice and planning, some medical centers can provide conscious sedation for patients with claustrophobia. Patients will typically need to avoid eating for six hours and drinking for two hours prior to sedation. Consult with your referring physician and imaging center if conscious sedation may be required.

Jewelry and other accessories should be left at home, if possible, or removed prior to the MRI scan. Because they can interfere with the magnetic field of the MRI unit, metal and electronic items are not allowed in the exam room. In addition to affecting the MRI images, these objects can become projectiles within the MRI scanner room and may cause you and/or others nearby harm. These items include:

- jewelry, watches, credit cards and hearing aids, all of which can be damaged
- pins, hairpins, metal zippers and similar metallic items, which can distort MRI images
- removable dental work
- pens, pocket knives and eyeglasses
- body piercings

In most cases, an MRI exam is safe for patients with metal implants, except for a few types. People with the following implants cannot be scanned and should not enter the MRI scanning area:

- cochlear (ear) implant
- some types of clips used for brain aneurysms
- some types of metal coils placed within blood vessels
- nearly all cardiac defibrillators and pacemakers

You should tell the technologist if you have medical or electronic devices in your body. These objects may interfere with the exam or potentially pose a risk, depending on their nature and the strength of the

MRI magnet. Many implanted devices will have a pamphlet explaining the MRI risks for that particular device. If you have the pamphlet, it is useful to bring that to the attention of the scheduler before the exam and bring it to your exam in case the radiologist or technologist has any questions. Some implanted devices require a short period of time after placement (usually six weeks) before being safe for MRI examinations. Examples include but are not limited to:

- artificial heart valves
- implanted drug infusion ports
- artificial limbs or metallic joint prostheses
- implanted nerve stimulators
- metal pins, screws, plates, stents or surgical staples

If there is any question of their presence, an x-ray may be taken to detect and identify any metal objects. In general, metal objects used in orthopedic surgery pose no risk during MRI. However, a recently placed artificial joint may require the use of another imaging procedure.

Patients who might have metal objects in certain parts of their bodies may also require an x-ray prior to an MRI. You should notify the technologist or radiologist of any shrapnel, bullets, or other pieces of metal that may be present in your body due to prior accidents. Foreign bodies near and especially lodged in the eyes are particularly important because they may move during the scan, possibly causing blindness. Dyes used in tattoos may contain iron and could heat up during an MRI scan, but this is rare. Tooth fillings and braces usually are not affected by the magnetic field, but they may distort images of the facial area or brain, so you should let the radiologist know about them.

Children younger than teenagers may need to be sedated in order to hold still for the procedures. Parents should ask about this beforehand and be made aware of food and drink restrictions that may be needed prior to sedation

## What does the equipment look like?

### CT scanner

The CT scanner is typically a large, box-like machine with a hole, or short tunnel, in the center. You will lie on a narrow examination table that slides into and out of this tunnel. Rotating around you, the x-ray tube and electronic x-ray detectors are located opposite each other in a ring, called a gantry. The computer workstation that processes the imaging information is located in a separate control room, where the technologist operates the scanner and monitors your examination in direct visual contact and usually with the ability to hear and talk to you with the use of a speaker and microphone.

### MRI scanner

The traditional MRI unit is a large cylinder-shaped tube surrounded by a circular magnet. You will lie on a moveable examination table that slides into the center of the magnet.

Some MRI units, called short-bore systems, are designed so that the magnet does not completely surround you. Some newer MRI machines have a larger diameter bore which can be more comfortable for larger size patients or patients with claustrophobia. Other MRI machines are open on the sides (open

MRI). Open units are especially helpful for examining larger patients or those with claustrophobia. Newer open MRI units provide very high quality images for many types of exams. Older open MRI units may not provide this same image quality. Certain types of exams cannot be performed using open MRI. For more information, consult your radiologist.

The computer workstation that processes the imaging information is located in a separate room from the scanner.

## How does the procedure work?

CT scanning combines special x-ray equipment with sophisticated computers to produce multiple images or pictures of the inside of the body. These cross-sectional images of the area being studied can then be examined on a computer monitor, printed or transferred to a CD.

In many ways CT scanning works very much like other x-ray examinations. Different body parts absorb the x-rays in varying degrees. It is this crucial difference in absorption that allows the body parts to be distinguished from one another on an x-ray film or CT electronic image.

In a conventional x-ray exam, a small amount of radiation is aimed at and passes through the part of the body being examined, recording an image on a special electronic image recording plate. Bones appear white on the x-ray; soft tissue, such as organs like the heart or liver, shows up in shades of gray, and air appears black.

With CT scanning, numerous x-ray beams and a set of electronic x-ray detectors rotate around you, measuring the amount of radiation being absorbed throughout your body. Sometimes, the examination table will move during the scan, so that the x-ray beam follows a spiral path. A special computer program processes this large volume of data to create two-dimensional cross-sectional images of your body, which are then displayed on a monitor. CT imaging is sometimes compared to looking into a loaf of bread by cutting the loaf into thin slices. When the image slices are reassembled by computer software, the result is a very detailed multidimensional view of the body's interior.

Refinements in detector technology allow nearly all CT scanners to obtain multiple slices in a single rotation. These scanners, called multislice CT or multidetector CT, allow thinner slices to be obtained in a shorter period of time, resulting in more detail and additional view capabilities.

Modern CT scanners are so fast that they can scan through large sections of the body in just a few seconds, and even faster in small children. Such speed is beneficial for all patients but especially children, the elderly and critically ill, all of whom may have difficulty in remaining still, even for the brief time necessary to obtain images.

For children, the CT scanner technique will be adjusted to their size and the area of interest to reduce the radiation dose.

MRI uses a powerful magnetic field, radio frequency pulses and a computer to produce detailed pictures of organs, soft tissues, bone and virtually all other internal body structures. The images can then be examined on a computer monitor, transmitted electronically, printed or copied to a CD. MRI does not use ionizing radiation (x-rays).

Unlike conventional x-ray examinations and computed tomography (CT) scans, MRI does not utilize ionizing radiation. Instead, radiofrequency pulses re-align hydrogen atoms that naturally exist within the body while you are in the scanner without causing any chemical changes in the tissues. As the hydrogen atoms return to their usual alignment, they emit different amounts of energy that vary according to the type of body tissue from which they come. The MR scanner captures this energy and creates a picture of the tissues scanned based on this information.

The magnetic field is produced by passing an electric current through wire coils in most MRI units. Other coils, located in the machine and in some cases, placed around the part of the body being imaged, send and receive radio waves, producing signals that are detected by the coils. The electric current does not come in contact with the patient.

A computer then processes the signals and generates a series of images, each of which shows a thin slice of the body. The images can then be studied from different angles by the interpreting radiologist.

Frequently, the differentiation of abnormal (diseased) tissue from normal tissues is better with MRI than with other imaging modalities such as x-ray, CT and ultrasound.

## How is the procedure performed?

Both CT and MR urography are usually done on an outpatient basis.

If CT urography is being performed, the technologist will begin by positioning you on the CT examination table, usually lying flat on your back or possibly on your side or stomach. You may be asked to change positions during portions of the examination. Straps and pillows may be used to help you maintain the correct position and to hold still during the exam.

Many scanners are fast enough that children can be scanned without sedation. In special cases, sedation may be needed for children who cannot hold still. Motion will cause blurring of the images and degrade the quality of the examination the same way that it affects photographs.

If contrast material is used, a nurse or technologist will inject the contrast through an IV line placed in the hand or arm.

Next, the table will move quickly through the scanner to determine the correct starting position for the scans. Then, the table will move slowly through the machine as the actual CT scanning is performed. Depending on the type of CT scan, the machine may make several passes.

You may be asked to hold your breath during the scanning. Any motion, whether breathing or body movements, can lead to artifacts on the images. This loss of image quality can resemble the blurring seen on a photograph taken of a moving object.

When the examination is completed, you will be asked to wait until the technologist verifies that the images are of high enough quality for accurate interpretation.

CT exams are generally painless, fast and easy. With multidetector CT, the amount of time that the patient needs to lie still is reduced.

If MR urography is being performed, the technologist will begin by positioning you on the MRI examination table, usually lying flat on your back or possibly on your side or stomach. You may be asked to change positions during portions of the examination. Straps and bolsters may be used to help you maintain the correct position and to hold still during imaging.

Devices that contain coils capable of sending and receiving radio waves may be placed around or adjacent to the area of the body being studied.

If a contrast material will be used in the MRI exam, a nurse or technologist will insert an intravenous (IV) line into a vein in your hand or arm. You will be moved into the magnet of the MRI unit and the radiologist and technologist will leave the room while the MRI examination is performed.

When the examination is complete, you may be asked to wait until the technologist or radiologist checks the images in case additional images are needed.

Your intravenous line will be removed.

MRI exams generally include multiple runs (sequences), some of which may last several minutes.

## What will I experience during and after the procedure?

### **If your urography exam involves CT:**

If an intravenous contrast material is used, you will feel a pin prick when the needle is inserted into your vein. You will likely have a warm, flushed sensation during the injection of the contrast materials and a metallic taste in your mouth that lasts for at most a minute or two. You may experience a sensation like you have to urinate; however, this is actually a contrast effect and subsides quickly.

When you enter the CT scanner, special light lines may be seen projected onto your body, and are used to ensure that you are properly positioned. With modern CT scanners, you will hear only slight buzzing, clicking and whirring sounds as the CT scanner's internal parts, not usually visible to you, revolve around you during the imaging process.

You will be alone in the exam room during the CT scan, unless there are special circumstances. For example, sometimes a parent wearing a lead shield may stay in the room with their child. However, the technologist will always be able to see, hear and speak with you through a built-in intercom system.

With pediatric patients, a parent may be allowed in the room but will be required to wear a lead apron to minimize radiation exposure.

After a CT exam, the intravenous line used to inject the contrast material will be removed by the technologist, and the tiny hole made by the needle will be covered with a small dressing. You can return to your normal activities.

### **If your urography exam involves MR:**

It is normal for the area of your body being imaged to feel slightly warm, but if it bothers you, notify the radiologist or technologist. It is important that you remain perfectly still while the images are being

obtained, which is typically only a few seconds to a few minutes at a time. You will know when images are being recorded because you will hear and feel loud tapping or thumping sounds when the coils that generate the radiofrequency pulses are activated. Some centers provide earplugs, while others use headphones to reduce the intensity of the sounds made by the MRI machine. You may be able to relax between imaging sequences, but will be asked to maintain your position without movement as much as possible.

You will usually be alone in the exam room during the MRI procedure. However, the technologist will be able to see, hear and speak with you at all times using a two-way intercom. Many MRI centers allow a friend or parent to stay in the room as long as they are also screened for safety in the magnetic environment.

Children will be given appropriately sized earplugs or headphones during the exam. MRI scanners are air-conditioned and well-lit. Music may be played through the headphones to help you pass the time.

In some cases, intravenous injection of contrast material may be administered before the images are obtained. The intravenous needle may cause you some discomfort when it is inserted and you may experience some bruising. There is also a very small chance of irritation of your skin at the site of the IV tube insertion. Some patients may sense a temporary metallic taste in their mouth after the contrast injection.

If you do not require sedation, no recovery period is necessary. You may resume your usual activities and normal diet immediately after the exam. On very rare occasions, a few patients experience side effects from the contrast material, including nausea, headache and pain at the site of injection. Similarly, patients are very rarely allergic to the contrast material and experience hives, itchy eyes or other reactions. If you experience allergic symptoms, notify the technologist. A radiologist or other physician will be available for immediate assistance.

## Who interprets the results and how do I get them?

A radiologist with expertise in supervising and interpreting radiology examinations will analyze the images and send an official report to your primary care physician or physician who referred you for the exam, who will discuss the results with you.

## What are the benefits vs. risks?

### Benefits

- Both CT and MR urography have been proven effective in detecting issues or abnormalities in parts of the urinary tract including the kidneys, bladder and ureters, or as a follow-up test to further examine for recurrent or new cancers of the urinary tract.
- Compared to other imaging tests, CT and MR urography both provide superior anatomic detail of the urinary tract and surrounding structures.



### **Exams involving CT imaging:**

- CT scanning is painless, noninvasive and accurate.
- A major advantage of CT is its ability to image bone, soft tissue and blood vessels all at the same time.
- Unlike conventional x-rays, CT scanning provides very detailed images of many types of tissue as well as the lungs, bones, and blood vessels.
- CT examinations are fast and simple; in emergency cases, they can reveal internal injuries and bleeding quickly enough to help save lives.
- CT has been shown to be a cost-effective imaging tool for a wide range of clinical problems.
- CT is less sensitive to patient movement than MRI.
- CT can be performed if you have an implanted medical device of any kind, unlike MRI.
- CT imaging provides real-time imaging, making it a good tool for guiding minimally invasive procedures such as needle biopsies and needle aspirations of many areas of the body, particularly the lungs, abdomen, pelvis and bones.
- A diagnosis determined by CT scanning may eliminate the need for exploratory surgery and surgical biopsy.
- No radiation remains in a patient's body after a CT examination.
- X-rays used in CT scans should have no immediate side effects.

### **Exams involving MR imaging:**

- MRI is a noninvasive imaging technique that does not involve exposure to ionizing radiation.
- MRI enables the discovery of abnormalities that might be obscured by bone with other imaging methods.
- The contrast material used in MRI exams is less likely to produce an allergic reaction than the iodine-based contrast materials used for conventional x-rays and CT scanning.

## **Risks**

### **Exams involving CT imaging:**

- There is always a slight chance of cancer from excessive exposure to radiation. However, the benefit of an accurate diagnosis far outweighs the risk.
- Because children are more sensitive to radiation, they should have a CT exam only if it is essential for making a diagnosis and should not have repeated CT exams unless absolutely necessary. CT scans in children should always be done with low-dose technique.

### **Exams involving MR imaging:**

- The MRI examination poses almost no risk to the average patient when appropriate safety guidelines are followed.
- Although the strong magnetic field is not harmful in itself, implanted medical devices that contain metal may malfunction or cause problems during an MRI exam.
- Nephrogenic systemic fibrosis is currently a recognized, but extremely rare, complication of MRI believed to be caused by the injection of high doses of gadolinium contrast material in patients with very poor kidney function.

### **Exams involving contrast material:**

- Manufacturers of intravenous contrast indicate mothers should not breastfeed their babies for 24-48 hours after contrast medium is given. However, both the American College of Radiology (ACR) and the European Society of Urogenital Radiology note that the available data suggest that it is safe to continue breastfeeding after receiving intravenous contrast. For further information please consult the ACR Manual on Contrast Media and its references.
- There is a very slight risk of an allergic reaction if contrast material is injected. Such reactions usually are mild and easily controlled by medication. If you experience allergic symptoms, a radiologist or other physician will be available for immediate assistance.

## **What are the limitations of Urography?**

A person who is very large may not fit into the opening of a conventional CT scanner or may be over the weight limit—usually 450 pounds—for the moving table.

High-quality images are assured only if you are able to remain perfectly still and follow breath-holding instructions while the images are being recorded. If you are anxious, confused or in severe pain, you may find it difficult to lie still during imaging.

A person who is very large may not fit into the opening of certain types of MRI machines.

The presence of an implant or other metallic object sometimes makes it difficult to obtain clear images due to streak artifacts from the metallic objects. Patient movement can have the same effect.

A very irregular heartbeat may affect the quality of images obtained using techniques that time the imaging based on the electrical activity of the heart, such as electrocardiography (EKG).

MRI may not always distinguish between cancer tissue and fluid, known as edema.

MRI typically costs more and may take more time to perform than other imaging modalities.

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