

## Magnetic Resonance Imaging (MRI) - Body

Magnetic resonance imaging (MRI) of the body uses a powerful magnetic field, radio waves and a computer to produce detailed pictures of the inside of your body. It may be used to help diagnose or monitor treatment for a variety of conditions within the chest, abdomen and pelvis. If you're pregnant, body MRI may be used to safely monitor your baby.



Tell your doctor about any health problems, recent surgeries or allergies and whether there's a possibility you are pregnant. The magnetic field is not harmful, but it may cause some medical devices to malfunction. Most orthopedic implants pose no risk, but you should always tell the technologist if you have any devices or metal in your body. Guidelines about eating and drinking before your exam vary between facilities. Unless you are told otherwise, take your regular medications as usual. Leave jewelry at home and wear loose, comfortable clothing. You may be asked to wear a gown. If you have claustrophobia or anxiety, you may want to ask your doctor for a mild sedative prior to the exam.

### What is MRI of the Body?

Magnetic resonance imaging (MRI) is a noninvasive test used to diagnose medical conditions.

MRI uses a powerful magnetic field, radio waves and a computer to produce detailed pictures of internal body structures. MRI does not use radiation (x-rays).

Detailed MR images allow doctors to examine the body and detect disease. The images can be reviewed on a computer monitor. They may also be sent electronically, printed or copied to a CD, or uploaded to a digital cloud server.

### What are some common uses of the procedure?

MR imaging of the body is performed to evaluate:

- organs of the chest and abdomen—including the heart, liver, biliary tract, kidneys, spleen, bowel, pancreas, and adrenal glands.
- pelvic organs including the bladder and the reproductive organs such as the uterus and ovaries in females and the prostate gland in males.
- blood vessels (including MR Angiography).
- lymph nodes.

Physicians use an MR examination to help diagnose or monitor treatment for conditions such as:

- tumors of the chest, abdomen or pelvis.
- diseases of the liver, such as cirrhosis, and abnormalities of the bile ducts and pancreas.
- inflammatory bowel disease such as Crohn's disease (<http://www.radiologyinfo.org/en/info/crohns-disease>) and ulcerative

colitis.

- heart problems, such as congenital heart disease.
- malformations of the blood vessels and inflammation of the vessels (vasculitis).
- a fetus in the womb of a pregnant woman.

## How should I prepare for the procedure?

You may need to wear a hospital gown. Or, you may be allowed to wear your own clothing if it is loose-fitting and has no metal fasteners.

Guidelines about eating and drinking before an MRI vary between specific exams and facilities. Unless you are told otherwise, take food and medications as usual.

Some MRI exams use an injection of contrast material. You may be asked if you have asthma or allergies to iodine contrast material, drugs, food, or the environment. MRI exams commonly use a contrast material called gadolinium. Gadolinium can be used in patients with iodine contrast allergy. A patient is much less likely to be allergic to gadolinium contrast than to iodine contrast. However, even if the patient has a known allergy to gadolinium, it may be possible to use it after appropriate pre-medication. *For more information on allergic reactions to gadolinium contrast, please consult the ACR Manual on Contrast Media (<https://www.acr.org/Clinical-Resources/Contrast-Manual>) .*

Tell the technologist or radiologist if you have any serious health problems or recently had surgery. Some conditions, such as severe kidney disease, may require the use of specific types of gadolinium contrast that are considered safe for patients with kidney disease. You may need a blood test to determine whether your kidneys are functioning normally.

Women should always tell their doctor and technologist if there is a chance they are pregnant. MRI has been used since the 1980s with no reports of any ill effects on pregnant women or their unborn babies. However, the baby will be in a strong magnetic field. Therefore, pregnant women should not have an MRI in the first trimester unless the benefit of the exam clearly outweighs any potential risks. Pregnant women should not receive gadolinium contrast unless absolutely necessary. *See the MRI Safety During Pregnancy (<http://www.radiologyinfo.org/en/info/safety-mri-pregnancy>) page for more information about pregnancy and MRI.*

If you have claustrophobia (fear of enclosed spaces) or anxiety, you may want to ask your doctor to prescribe a mild sedative prior to your exam.

Leave all jewelry and other accessories at home or remove them prior to the MRI scan. Metal and electronic items can interfere with the magnetic field of the MRI unit, and they are not allowed in the exam room. They may cause burns or become harmful projectiles within the MRI scanner room. 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
- mobile phones, electronic watches and tracking devices.

In most cases, an MRI exam is safe for patients with metal implants, except for a few types. People with the following implants may not be scanned and should not enter the MRI scanning area without first being evaluated for safety:

- some cochlear (ear) implants
- some types of clips used for brain aneurysms

- some types of metal coils placed within blood vessels
- some older cardiac defibrillators and pacemakers

Tell the technologist if you have medical or electronic devices in your body. These devices may interfere with the exam or pose a risk. Many implanted devices will have a pamphlet explaining the MRI risks for that particular device. If you have the pamphlet, bring it to the attention of the scheduler before the exam. MRI cannot be performed without confirmation and documentation of the type of implant and MRI compatibility. You should also bring any pamphlet to your exam in case the radiologist or technologist has any questions.

If there is any question, an x-ray can detect and identify any metal objects. Metal objects used in orthopedic surgery generally pose no risk during MRI. However, a recently placed artificial joint may require the use of a different imaging exam.

Tell the technologist or radiologist about any shrapnel, bullets, or other metal that may be in your body. Foreign bodies near and especially lodged in the eyes are very important because they may move or heat up during the scan and cause blindness. Dyes used in tattoos may contain iron and could heat up during an MRI scan. This is rare. Tooth fillings, braces, eyeshadows and other cosmetics usually are not affected by the magnetic field. However, they may distort images of the facial area or brain. Tell the radiologist about them.

Infants and young children often require sedation or anesthesia to complete an MRI exam without moving. This depends on the child's age, intellectual development and the type of exam. Sedation can be provided at many facilities. A specialist in pediatric sedation or anesthesia should be available during the exam for your child's safety. You will be told how to prepare your child. Some facilities may have personnel who work with children to help avoid the need for sedation or anesthesia. They prepare children by showing them a dummy MRI scanner and playing the noises they might hear during the exam. They also answer any questions and explain the procedure to relieve anxiety. Some facilities also provide goggles or headsets so the child can watch a movie while the scan is being done. This helps the child stay still and allows for good quality images.

## What does the equipment look like?

The traditional MRI unit is a large cylinder-shaped tube surrounded by a circular magnet. You will lie on a 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 patients or those with claustrophobia. "Open" MRI units are open on the sides. They are especially helpful for examining larger patients or those with claustrophobia. Open MRI units can provide high quality images for many types of exams. Certain exams cannot be performed using open MRI. For more information, consult your radiologist.

## How does the procedure work?

Unlike x-ray and computed tomography (CT) exams, MRI does not use radiation. Instead, radio waves re-align hydrogen atoms that naturally exist within the body. This does not cause any chemical changes in the tissues. As the hydrogen atoms return to their usual alignment, they emit different amounts of energy depending on the type of body tissue they are in. The scanner captures this energy and creates a picture using this information.

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

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

MRI is able to tell the difference between diseased tissue and normal tissue better than x-ray, CT and ultrasound.

## How is the procedure performed?

MRI exams may be done on an outpatient basis.

You will be positioned on the moveable exam table. Straps and bolsters may be used to help you stay still and maintain your position.

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

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

If a contrast material is used, a doctor, nurse or technologist will insert an intravenous catheter (IV line) into a vein in your hand or arm that will be used to inject the contrast material.

You will be placed into the magnet of the MRI unit. The technologist will perform the exam while working at a computer outside of the room.

If a contrast material is used during the exam, it will be injected into the intravenous line (IV) after an initial series of scans. More images will be taken during or following the injection.

When the exam is complete, you may be asked to wait while the radiologist checks the images in case more are needed.

Your IV line will be removed after the exam is over.

Depending on the type of exam and the equipment used, the entire exam is usually completed in 30 to 50 minutes.

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

Most MRI exams are painless. However, some patients find it uncomfortable to remain still. Others may feel closed-in (claustrophobic) while in the MRI scanner. The scanner can be noisy. Sedation may be arranged for anxious patients, but fewer than one in 20 require it.

It is normal for the area of your body being imaged to feel slightly warm. If it bothers you, tell the radiologist or technologist. It is important that you remain perfectly still while the images are being taken. This 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. These are made when the coils that generate the radio waves are activated. You will be provided with earplugs or headphones to reduce the sounds made by the scanner. You may be able to relax between imaging sequences. However, you will be asked to keep the same position without moving as much as possible.

You will usually be alone in the exam room. However, the technologist will be able to see, hear and speak with you at all times using a two-way intercom. Many facilities allow a friend or parent to stay in the room if they have also been screened for safety.

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 pass the time.

In some cases, IV injection of contrast material may be given before the images are obtained. The IV needle may cause you some discomfort and you may experience some bruising. There is also a very small chance of skin irritation at the site of the IV tube insertion. Some patients may have 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. These may include nausea, headache and pain at the site of injection. It is very rare that patients experience hives, itchy eyes or other allergic reactions to the contrast material. If you have allergic symptoms, tell the technologist. A radiologist or other doctor will be available for immediate assistance.

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

A radiologist, a doctor trained to supervise and interpret radiology exams, will analyze the images. The radiologist will send a signed report to your primary care or referring physician, who will share the results with you.

Follow-up exams may be needed. If so, your doctor will explain why. Sometimes a follow-up exam is done because a potential abnormality needs further evaluation with additional views or a special imaging technique. A follow-up exam may also be done to see if there has been any change in an abnormality over time. Follow-up exams are sometimes the best way to see if treatment is working or if an abnormality is stable or has changed.

## What are the benefits vs. risks?

### Benefits

- MRI is a noninvasive imaging technique that does not involve exposure to radiation.
- MR images of the soft-tissue structures of the body—such as the heart, liver and many other organs— is more likely in some instances to identify and accurately characterize diseases than other imaging methods. This detail makes MRI an invaluable tool in early diagnosis and evaluation of many focal lesions and tumors.
- MRI has proven valuable in diagnosing a broad range of conditions, including cancer, heart and vascular disease, and muscular and bone abnormalities.
- MRI can detect abnormalities that might be obscured by bone with other imaging methods.
- MRI allows physicians to assess the biliary system noninvasively and without contrast injection.
- The MRI gadolinium contrast material is less likely to cause an allergic reaction than the iodine-based contrast materials used for x-rays and CT scanning.
- MRI provides a noninvasive alternative to x-ray, angiography and CT for diagnosing problems of the heart and blood vessels.

### Risks

- The MRI exam poses almost no risk to the average patient when appropriate safety guidelines are followed.
- If sedation is used, there is a risk of using too much. However, your vital signs will be monitored to minimize this risk.
- The strong magnetic field is not harmful. However, it may cause implanted medical devices to malfunction or cause distortion of the images.
- Nephrogenic systemic fibrosis is a recognized, but rare, complication related to injection of gadolinium contrast. It usually occurs in patients with serious kidney disease. Your doctor will carefully assess your kidney function before considering a contrast injection.
- There is a very slight risk of an allergic reaction if contrast material is used. Such reactions are usually mild and controlled by medication. If you have an allergic reaction, a doctor will be available for immediate assistance.
- IV contrast manufacturers indicate mothers should not breastfeed their babies for 24-48 hours after contrast material is given. However, the most recent American College of Radiology (ACR) Manual on Contrast Media reports that studies show the amount of contrast absorbed by the infant during breastfeeding is extremely low. *For further information please consult the ACR Manual on Contrast Media (<https://www.acr.org/Clinical-Resources/Contrast-Manual>) and its references.*

## What are the limitations of MRI of the Body?

High-quality images depend on your ability 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 certain types of MRI machines. There are weight limits on the scanners.

Implants and other metallic objects can make it difficult to obtain clear images. Patient movement can have the same effect.

A very irregular heartbeat may affect the quality of images. This is because some techniques time the imaging based on the electrical activity of the heart.

Breathing may cause artifacts, or image distortions, during MRIs of the chest, abdomen and pelvis. Bowel motion is another source of motion artifacts in abdomen and pelvic MRI studies. This is less of a problem with state-of-the art scanners and techniques.

Although there is no reason to believe that MRI harms the fetus, pregnant women should not have an MRI exam during their first trimester unless medically necessary.

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 methods. Talk to your insurance provider if you have concerns about the cost of MRI.

## Which test, procedure or treatment is best for me?

- Staging of Pancreatic Ductal Adenocarcinoma (<http://www.radiologyinfo.org/en/info/article-appropriateness-criteria#d009b72cd1f74ed9978720ffb5a03e4f>)

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