



Magnetic Resonance Imaging (MRI) Safety

What is MRI and how does it work?

Magnetic resonance imaging, or MRI, is a way of obtaining detailed images of organs and tissues throughout the body without the need for x-rays or "ionizing" radiation. Instead, MRI uses a powerful magnetic field, radio waves, rapidly changing magnetic fields, and a computer to create images that show whether or not there is an injury, disease process, or abnormal condition present.



For the MRI exam, the patient is placed inside of the MR system or scanner—typically a large donut-shaped device that is open on both ends. The powerful magnetic field aligns atomic particles called protons that exist in most body tissues. The applied radio waves then interact with these protons to produce signals that are picked up by a receiver within the MR scanner. The signals are specially characterized using the rapidly changing magnetic field. With the help of computer processing, images of tissues are created as "slices" that can be viewed in any orientation.

An MRI examination causes no pain, and the electromagnetic fields produce no known tissue damage of any kind. The MR scanner may make loud tapping, knocking, or other noises at times during the procedure. Earplugs are provided to prevent problems that may be associated with this noise. At all times, you will be monitored and you will be able to communicate with the MRI technologist or the MR scanner operator using an intercom system or by other means.

What is MRI used for?

MRI is the preferred procedure for diagnosing a large number of potential problems or abnormal conditions that may affect different parts of the body. In general, MRI creates pictures that can show differences between healthy and unhealthy or abnormal tissues. Physicians use MRI to examine the brain, spine, joints (e.g., knee, shoulder, hip, wrist, and ankle), abdomen, pelvic region, breast, blood vessels, heart and other body parts.

How safe is MRI?

The powerful magnetic field of the MR system can attract objects made from certain metals (i.e., known as ferromagnetic) and cause them to move suddenly and with great force. This can pose a possible risk to the patient or anyone in the object's "flight path." Therefore, great care is taken to be certain that external objects such as ferromagnetic screwdrivers and oxygen tanks are not brought into the MR system area. As a patient, it is vital that you remove all metallic belongings in advance of an MRI exam, including external hearing aids, watches, jewelry, cell phones, and items of clothing that have metallic threads or fasteners. Additionally, makeup, nail polish, or other cosmetics that may contain metallic particles should be removed if applied to the area of the body undergoing the MRI examination.

The powerful magnetic field of the MR system will pull on any iron-containing object in the body such as a medical implant, certain aneurysm clips or certain medication pumps. Every MRI facility has a comprehensive screening procedure and protocols. When carefully followed, these steps ensure that the MRI technologist and radiologist know about the presence of any metallic implants and materials in the patient. Special precautions can usually be taken. In some unusual cases, due to the presence of an unacceptable implant or device, the exam may have to be canceled. For example, the MRI exam will not be performed if a ferromagnetic aneurysm clip is present because there is a risk of the clip moving and causing serious harm to the patient. In some cases, certain medical implants can heat substantially during the MRI exam as a result of the radiofrequency energy that is used for the procedure. This heating may result in an injury to the patient. Therefore, it is very important to inform the MRI technologist about any implant or other internal object that you may have prior to entering the MR scanner room.

The powerful magnetic field of the MR system may damage an external hearing aid or cause a heart pacemaker, electrical stimulator, or neurostimulator to malfunction or cause injury. If you have a bullet or any other metallic fragment in your body there is a potential risk that it could change position and possibly cause an injury.

In addition, a metallic implant or other object may cause signal loss or alter the MR images making it difficult for the radiologist to see the images correctly. This may be unavoidable, but if the radiologist knows about it, allowances can be made when obtaining and interpreting the MR images.

For some MRI exams, a contrast material known as a gadolinium contrast agent may be injected into a vein to help improve the information seen on the MR images. Unlike the contrast materials used in x-ray exams or computed tomography (CT) scans, a gadolinium contrast agent does not contain iodine and, therefore, rarely causes an allergic reaction or other problem. However, if you have a history of kidney disease, kidney failure, kidney transplant, liver disease, or other conditions, you must inform the MRI technologist and/or radiologist before receiving a gadolinium contrast agent. If you are unsure about the presence of these conditions, please discuss these matters with the MRI technologist or radiologist prior to the MRI examination.

How should I prepare for my MRI exam?

You will typically receive a gown to wear during your MRI examination. Before entering the MR system room, you will be asked a variety of questions (i.e., using a special screening form) including if you have implants or devices. Next, you will be instructed to remove all metallic objects from pockets and hair, as well as metallic jewelry. Additionally, any individual that will be going with you in the MRI scanner room will be required to follow these same instructions and procedures including filling out the same forms. If you have questions or concerns, please discuss them with the MRI technologist or radiologist prior to the MRI examination.

As previously indicated, you will be asked to fill out a screening form asking about anything that might create a health risk or interfere with the MRI exam. Items that may create a health hazard or other problem during an MRI include:

- Certain cardiac pacemakers or implantable cardioverter defibrillators (ICDs)
- Ferromagnetic metallic vascular clips placed to prevent bleeding from intracranial aneurysms or blood vessels
- Some external or implanted medication pumps (such as those used to deliver insulin, pain-relieving drugs, or chemotherapy)
- Certain cochlear (i.e., for hearing) implants
- Certain neurostimulation systems
- Catheters that have metallic components
- A bullet, shrapnel or other type of metallic fragment
- A metallic foreign body located within or near the eye (such an object generally can be seen on an x-ray; metal workers are most likely to have this problem)

Important note: Some items, including certain cardiac pacemakers, ICDs, neurostimulation systems, cochlear implants, and medication pumps are acceptable for MRI. However, the MRI technologist and radiologist must know the exact type that you have in order to follow special procedures to ensure your safety. Therefore, in order to help with the pre-MRI screening procedure, it is important for you to obtain information about any implant that you may have and to provide it to the MRI technologist.

Items that need to be removed by patients and individuals before entering the MR system room include:

- Purse, wallet, money clip, credit cards, cards with magnetic strips
- Electronic devices such as beepers, cell phones, smartphones and tablets
- Hearing aids
- Metallic jewelry and watches
- Pens, paper clips, keys, coins
- Hair barrettes, hairpins, hair clips and some hair ointments
- Shoes, belt buckles, safety pins

- Any article of clothing that has metallic fibers or threads, metallic zippers, buttons, snaps, hooks, or underwire

Objects that may interfere with image quality if close to the area being scanned include:

- Metallic spinal rod
- Plates, pins, screws, or metal mesh used to repair a bone or joint
- Joint replacement or prosthesis
- Metallic jewelry including those used for body piercing or body modification
- Some tattoos or tattooed eyeliner (these alter MR images, and there is a chance of skin irritation or swelling; black and blue pigments are the most troublesome)
- Makeup (such as eye shadow and eyeliner), nail polish or other cosmetic that contains metal
- Dental fillings or braces (while usually unaffected by the magnetic field, these may distort images of the facial area or brain; the same is true for orthodontic braces and retainers)

An example of the MRI examination

The MRI examination is performed in a special room that houses the MR system or "scanner." You will be escorted into the room by a staff member of the MRI facility and asked to lie down on a comfortably padded table that gently glides you into and out of the scanner. The typical scanner is open on each end, or at least two sides.

In general, in preparation for the MRI examination, you will be required to wear earplugs or headphones to protect your hearing because many scanning procedures produce loud noises. These loud noises are normal and should not worry you.

For some MRI exams, a contrast agent called gadolinium may be injected into a vein to help obtain a clearer picture of the area being examined. Typically, at the beginning of the imaging procedure, a nurse or MRI technologist will place an intravenous line in your arm or hand vein using a small needle. This will allow injection of the gadolinium contrast agent. The line will be connected to a saline solution that will drip through the intravenous line to prevent clotting until the actual contrast agent is injected at some point during the exam. Sometimes the contrast agent is injected with an automatic device and sometimes it is necessary for the technologist or nurse to come into the room to inject the contrast agent. They may even have to slide the table out of the scanner to do this.

The most important thing for the patient to do is to lie still and relax. Most MRI exams take between 15 to 45 minutes to complete depending on the body part imaged and how many images are needed, although some exams may take up to 60 minutes or longer. You will be told ahead of time how long your scan is expected to take.

You will be asked to remain perfectly still during the time the imaging takes place, but between sequences some minor movement may be allowed. The MRI technologist will advise you, accordingly.

When the MRI exam begins, you may breathe normally. However, for certain examinations it may be necessary for you to hold your breath for a short period of time.

During your MRI examination, the MR system operator will be able to speak to you, hear you, and observe you at all times. Consult the MR scanner operator if you have questions or feel anything unusual.

When the MRI exam is over, you may be asked to wait until the images are examined to determine if more images are needed. After the exam, you have no restrictions and can go about your normal activities.

Once the entire MRI examination is completed, the images will be reviewed by a radiologist, a physician who has been specially trained to interpret the scans for your doctor.

The question of anxiety or claustrophobia

Some patients who undergo MRI examinations may feel confined, closed-in, or frightened. Perhaps one out of every twenty people may require a mild sedative to remain calm. Today, many patients avoid this problem when examined in one of the newer scanners that have a more "open" design. Some MRI centers permit a relative or friend to be present in the MR system room, which also has a calming effect for the patient. If patients are properly prepared and know what to expect, it is almost always possible to complete the examination.

Pregnancy and MRI

If you are pregnant or suspect you are pregnant, you should inform the MRI technologist and/or radiologist during the screening procedure that is conducted and before the MRI examination. In general, there is no known risk of using MRI in pregnant patients. However, MRI is reserved for use in pregnant patients only to address very important problems or suspected abnormalities. In any case, MRI is safer for the fetus than imaging with x-rays or computed tomography (CT). For additional information see MRI During Pregnancy.

Breast-feeding and MRI

You should inform the MRI clinic that you are breast-feeding when scheduling your MRI exam. This is particularly important if you receive an MRI contrast agent. One option under this circumstance is to pump breast milk before the MRI exam, which can be used to feed the infant until the contrast agent has been cleared from the body. It usually takes about 24 hours for the contrast agent to clear the body. The clinic or radiologist will provide additional information to you regarding this matter.

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