



## 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 procedure, the patient is placed inside of the MR scanner—typically a large doughnut-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 cause 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, and, 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. However, using earplugs prevents 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 in many different parts of the body. In general, MRI creates pictures that can show differences between healthy and unhealthy 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 will attract iron-containing (also known as ferromagnetic) objects and may 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." 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 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 certain aneurysm clips or certain medication pumps. Every MRI facility has a comprehensive screening procedure and protocol that, when carefully followed, ensures that the MRI technologist and radiologist know about the presence of any metallic implants and materials so that special precautions can 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 examination as a result of the radiofrequency energy that is used for the procedure, which may also result in patient injuries. Therefore, it is very important to inform the MRI technologist about any implant or other internal object that you may have.

The 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 distort the MR images. 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 called gadolinium may be injected into a vein to help improve the information seen on the MR images. Unlike contrast materials used in x-ray exams or computed tomography (CT) scans, gadolinium 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 gadolinium. 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 and any accompanying friend or relative will be asked questions (i.e., using a screening form) regarding the presence of implants or devices and will be instructed to remove all metallic objects from pockets and hair, as well as metallic jewelry. Additionally, any accompanying individual will need to fill out a screening form to ensure that he or she may safely enter the MR system room. If you have questions or concerns, please discuss them with the MRI technologist or radiologist prior to the MRI examination.

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

- Certain cardiac pacemakers or implantable cardioverter defibrillators (ICDs)
- Ferromagnetic metallic vascular clips placed to prevent bleeding from intracranial aneurysms
- Some implanted or external medication pumps (such as those used to deliver insulin, pain-relieving drugs, or chemotherapy)
- Certain cochlear (inner ear) implants
- Certain neurostimulation systems
- Catheters that have metallic components
- A bullet, shrapnel or other type of metallic fragment
- A metallic foreign body 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, neurostimulation systems 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.

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 or cell phones
- Hearing aids
- Metal jewelry, watches
- Pens, paper clips, keys, coins
- Hair barrettes, hairpins
- 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, nail polish or other cosmetic that contains metal
- Dental fillings (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 both ends.

In general, in preparation for the MRI examination, you will be required to wear earplugs or headphones to protect your hearing because, when certain scanners operate, they may produce loud noises. These loud noises are normal and should not worry you.

For some MRI studies, a contrast agent called gadolinium may be injected into a vein to help obtain a clearer picture of the area being examined. At some point during the examination, a nurse or MRI technologist will slide the table out of the scanner in order to inject the contrast agent. This is typically done through a small needle connected to an intravenous line that is placed in an arm or hand vein. A saline solution will drip through the intravenous line to prevent clotting until the contrast material is injected at some point during the exam.

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 may take as long as 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 procedure 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 scanner operator if you have any questions or feel anything unusual.

When the MRI procedure is over, you may be asked to wait until the images are examined to determine if more images are needed. After the scan, 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 specially-trained physician who is able 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 in twenty may require a 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. 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 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 your radiologist if you are breast-feeding at the time of a scheduled MRI study if you may need to receive an MRI contrast agent. One option under this circumstance is to pump breast milk before the study, to be used until injected contrast material has cleared from the body, which typically takes about 24 hours. The radiologist will provide additional information to you regarding this matter.

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