MRI of the Musculoskeletal System

What is MRI of the Musculoskeletal System?

Magnetic resonance imaging (MRI) is a noninvasive, usually painless medical test that helps physicians diagnose and treat medical conditions.

MR imaging uses a powerful magnetic field, radio waves 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 or printed. MRI does not use ionizing radiation (x-rays).

Detailed MR images allow physicians to better evaluate parts of the body and certain diseases that may not be assessed adequately with other imaging methods such as x-ray, ultrasound or computed tomography (also called CT or CAT scanning).

What are some common uses of the procedure?

MR imaging is usually the best choice for examining the:

- body's major joints.
- spine for disk disease.
- soft tissues of the extremities (muscles and bones).

MR imaging is typically performed to diagnose or evaluate:

- degenerative joint disorders such as arthritis and meniscus tears (knee).
- fractures (in selected patients).
- joint abnormalities due to trauma (tendon tears for example).
- spinal disk abnormalities (herniated disk for example).
- the integrity of the spinal cord after trauma.
- sports-related injuries and work-related disorders caused by repeated strain, vibration or forceful impact.
- infections (osteomyelitis for example).
- tumors (primary tumors and metastases for example) involving bones and joints.
- pain, swelling or bleeding in the tissues in and around the joints and bones.

How should I prepare?

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.

Guidelines about eating and drinking before an MRI exam vary at different facilities. Unless you are told otherwise, you may follow your regular daily routine and take medications as usual.

Some MRI examinations may require the patient to swallow contrast material or receive an injection of contrast into the bloodstream. The radiologist or technologist may ask if you have allergies of any kind such as hay fever, hives, allergic asthma, or to food or drugs. However, the contrast material used for an MRI exam, called gadolinium, does not contain iodine and is less likely to cause an allergic reaction.

The radiologist should also know if you have any serious health problems and what surgeries you have undergone. Some conditions, such as kidney disease and sickle cell anemia, may prevent you from having an MRI with contrast material.

Women should always inform their physician or technologist if there is any possibility that they are pregnant. Because the risks of an MRI exam to the baby are unknown, pregnant women should not have this exam unless the potential benefit from the MRI is assumed to outweigh the potential risks.
If you have claustrophobia (fear of enclosed spaces) or anxiety, you may want to ask your physician for a prescription for a mild sedative.

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 objects are not allowed in the exam 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, pocketknives and eyeglasses.

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 area:

- internal (implanted) defibrillator
- cochlear (ear) implant
- clips used on brain aneurysms

You should tell the technologist if you have medical or electronic devices in your body, because they may interfere with the exam or potentially pose a risk. Examples include:

- artificial heart valves
- implanted drug infusion ports
- infusion catheter
- intrauterine device (IUD)
- implanted electronic device, including a cardiac pacemaker
- artificial limbs or metallic joint prostheses
- implanted nerve stimulators
- metal pins, screws, plates or surgical staples.

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. If there is any question of their presence, an x-ray may be taken to detect the presence of any metal objects.

Sheet metal workers and others who might have metal objects such as shrapnel in their bodies may also require an x-ray prior to an MRI. Dyes used in tattoos may contain iron and could heat up during MRI, but this is rarely a problem. Tooth fillings and braces usually are not affected by the magnetic field but they may distort images of the facial area or brain, so the radiologist should be aware of them.

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 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; others are open on all sides (open MRI). These units are especially helpful for examining patients who are fearful of being in a closed space and those who are very obese, but they may not provide the same image quality as the regular systems and cannot be used for certain types of scans.
body being studied. In the magnetic field, these protons change their position, producing signals that are detected by the coils.

A computer then processes the signals and generates a series of images each of which shows a thin slice of the body. The computer compiles the images into a three-dimensional representation of the body, which can be studied from many different angles on a computer monitor.

Because protons are most abundant in water molecules, MR images show differences in water content between various body tissues. As a result, MRI is especially suited to detecting disorders that increase fluid in diseased areas of the body, for example, areas affected by tumors, infection and inflammation. Overall, the differentiation of abnormal (diseased) tissue from normal tissues is significantly easier with MRI than with other imaging modalities such as x-ray, CT and ultrasound.

**How is it performed?**

MRI examinations are usually done on an outpatient basis.

You will be positioned on the moveable examination table. Straps and bolsters may be used to help you stay still and maintain the correct position during imaging.

Small 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. A saline solution will drip through the IV to prevent blockage of the IV line until the contrast material is injected.

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.

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

When the examination is completed, you may be asked to wait until the technologist 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.

The entire examination is usually completed within 45 minutes.

In selected patients, contrast material may be injected into the joint of concern (typically in the shoulder) before MRI in order to image the joint structures in more detail.

MR spectroscopy, which provides additional information on the chemicals present in the body's cells, may also be performed during the MRI exam and will add approximately 15 minutes to the exam time.

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

Most MRI exams are painless.

Some patients, however, find it uncomfortable to remain still during MR imaging. Others experience a sense of being closed-in (claustrophobia). Therefore, sedation can be arranged for those patients who anticipate anxiety, but fewer than one in 20 require it.

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 recorded, 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 tapping or thumping sounds when the coils that create the magnetic field are turned on. You will be able to relax between imaging sequences.

You will be alone in the exam room during the MR imaging, 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.

You may request earplugs to reduce the noise of the MRI scanner, which produces loud thumping and humming noises during imaging. MRI scanners are air-conditioned and well-lit. Some scanners have music or a built-in television to help you pass the time.

When the contrast material is injected, it is normal to feel coolness and a flushing for a minute or two. The intravenous needle may cause you some discomfort when it is inserted and once it is removed, you may experience some bruising. There is also a very small chance of irritation or infection of your skin at the site of the IV tube insertion.

If you have not been sedated, no recovery period is necessary. You may resume your usual activities and normal diet immediately after the exam. A few patients experience side effects from the contrast material, including nausea and local pain. Very rarely, patients are allergic to the contrast material and experience hives and itchy eyes.
It is recommended that nursing mothers not breastfeed for 36 to 48 hours after an MRI with a contrast material.

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

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

**What are the benefits vs. risks?**

**Benefits**

- MRI is an imaging technique that does not require exposure to radiation.
- MR images of the soft-tissue structures of the body (particularly muscles, bones and joints) are clearer and more detailed than with other imaging methods. This detail makes MRI an invaluable tool in early diagnosis and evaluation of many conditions, including tumors.
- MRI can distinguish abnormal tissues from normal tissues much more accurately than other imaging tests (x-ray, CT etc).
- MRI enables the detection 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 materials used for conventional x-rays and CT scanning.
- MR images allow the physician to clearly see even very small tears and injuries to tendons, ligaments and muscles and some fractures that cannot be seen on x-rays.

**Risks**

- The MRI examination poses almost no risk to the average patient when appropriate safety guidelines are followed.
- If sedation is used there are risks of excessive sedation. The technologist or nurse monitors your vital signs to minimize this risk.
- Although the strong magnetic field is not harmful in itself, medical devices that contain metal may malfunction or cause problems during an MRI exam.
- 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. There also is a very small risk of skin infection at the site of injection. Nephrogenic systemic fibrosis is currently a recognized, but rare, complication of MRI believed to be caused by the injection of certain (but not all) MRI contrast material in patients with poor kidney function.
- If contrast material is injected into the joint, there may be related complications.

**What are the limitations of a Musculoskeletal MRI?**

High-quality images are assured only if you are able to remain perfectly still 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 obese may not fit into the opening of a conventional MRI machine.

The presence of an implant or other metallic object often makes it difficult to obtain clear images and patient movement can have the same effect.

MRI generally is not recommended for patients who have been acutely injured. This is because traction devices and life support equipment must be kept away from the area to be imaged. Furthermore, the examination takes longer than other imaging modalities (typically x-ray and CT) and the results may not be immediately available as is often necessary in trauma situations.

Although there is no reason to believe that magnetic resonance imaging harms the fetus, the effects of a strong magnetic field are not well understood. For this reason pregnant women usually are advised not to have an MRI exam unless medically necessary.

MRI may not always distinguish between tumor tissue and edema fluid. It cannot detect calcium present in a tumor. Detection of calcium (in tumors or other issues) is limited with MRI.

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

Initial assessment of bones and joints is typically performed with x-rays.
Sample image: MR of the knee - side (lateral) view, showing distal or lowest part of femur, the patella (knee cap) and proximal (upper) tibia. The lateral meniscus is seen as a dark bow-tie like structure. The patellar tendon is also clearly seen at the front of the knee connecting the patella with the tibia.

Sample image: MR of the right shoulder looking at rotator cuff and head of humerus as well as glenoid portion of scapula.

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