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MR Imaging (MRI) - Musculoskeletal

This procedure is reviewed by a physician with expertise in the area presented and is further reviewed by committees from the American College of Radiology (ACR) and the Radiological Society of North America (RSNA), comprising physicians with expertise in several radiologic areas.

What is MR Imaging (MRI) of the Musculoskeletal System?

Magnetic resonance imaging (MRI) uses radio waves and a strong magnetic field rather than x-rays to provide clear and detailed pictures of internal organs and tissues. The parts of the musculoskeletal system that are most frequently imaged with MRI are the spine, knee and shoulder. However, MRI has also been used to study almost every joint in the body, including the hips, wrists, and hands. MRI requires specialized equipment and expertise and allows evaluation of some body structures that may not be as visible with other imaging methods.

What are some common uses of the procedure?

Because MRI can give such clear pictures of soft tissue structures near and around bones, it is usually the best choice for examination of the body's major joints, the spine for disk disease, and soft tissues of the extremities. MRI is widely used to diagnose sports-related injuries, as well as work-related disorders caused by repeated strain, vibration, or forceful impact.

Using MRI images, physicians can locate and identify the cause of pain, swelling, or bleeding in the tissues in and around the joints and bones. The images allow the physician to clearly see even very small tears and injuries to tendons, ligaments and muscles, and even some fractures that cannot be seen on x-rays.

In addition, MRI images can give physicians a clear picture of degenerative disorders such as arthritis, deterioration of joint surfaces, or a herniated disc. Neurosurgeons often use MRI to evaluate the integrity of the spinal cord after trauma.

Finally, MRI is also useful for the diagnosis and characterization of infections (for example osteomyelitis) and tumors (for example metastases) involving bones and joints.

How should I prepare for the procedure?

Because the strong magnetic field used for MRI will pull on any ferromagnetic metal object implanted in the body, MRI staff will ask whether you have a prosthetic hip, an aneurysm clip in the brain, heart pacemaker (or artificial heart valve), implanted port (brand names Port-o-cath, Infusaport, Lifeport), intrauterine device (IUD), or any metal plates, pins, screws, or surgical staples in your body. In most cases, surgical staples, plates, pins and screws pose no risk during MRI if they have been in place for more than 4-6 weeks. Dyes used in tattoos and permanent eyeliner may contain metallic iron oxide and could heat up during MRI; however, this is rare. You will be asked if you have ever had a bullet or shrapnel in your body, or ever worked with metal. If there is any question of metal fragments, especially in the eye, you may be asked to have an x-ray that will detect any such metal objects. Tooth fillings 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. The same is true of braces, which may make it hard to "tune" the MRI unit to your body. You will be asked to remove anything that might degrade MRI images of the head, including hairpins, jewelry, eyeglasses, hearing aids, and any removable dental work.

The radiologist or technologist may ask if you have any drug allergies and whether you have undergone any surgery in the past. If you are or might be pregnant, mention it to the MRI staff.

Some patients who undergo MRI in an enclosed unit may feel confined or claustrophobic. If you are not easily reassured, a sedative may be administered. Roughly one in 20 patients will require medication.

What does the equipment look like?

The conventional MRI unit is a closed cylindrical magnet in which the patient must lie totally still for several minutes at a time, and consequently may feel closed-in or truly claustrophobic. However, new patient-friendly designs are rapidly coming into routine use. These "short-bore" systems are wider and shorter and do not fully enclose the patient. Some newer units are open on all sides; however, the image quality may vary.

Below are examples of the MRI equipment that may be used.

How does the procedure work?

MRI is a unique imaging method because, unlike the usual radiographs (x-rays), radioisotope studies, and even CT, it does not rely on ionizing radiation. Instead, radio waves are directed at protons, the nuclei of hydrogen atoms, in a strong magnetic field. The protons are first "excited" and then "relaxed," emitting radio signals that can be computer-processed to form an image.

In the body, protons are most abundant in the hydrogen atoms of water — the "H" of H_2O — so that an MRI image shows differences in the water content and distribution in various body tissues. Even different types of tissue within the same organ, such as the gray and white matter of the brain, can easily be distinguished. Typically an MRI exam consists of two to six imaging sequences, each lasting two to 15 minutes. Each sequence has its own degree of contrast and shows a cross section of the body in one of several planes (right to left, front to back, upper to lower).

How is the procedure performed?

The patient is comfortably positioned on a special table that slides into the MRI system opening where the magnetic field is created. Then the radiologist and technologist leave the room and the individual MRI sequences are performed. The patient will hear tapping noises during the exam. The tapping is created when magnetic field gradient coils are switched on and off to measure the MRI signal reflecting back out of the patient's body. The patient is able to communicate with the radiologist or technologist at any time using an intercom. Also, many MRI centers allow a friend or, if a child is being examined, a parent, to stay in the room.

Depending on how many images are needed, the exam will generally take from 15 to 45 minutes, although a very detailed study may take longer. You will be asked not to move during the actual imaging process, but between sequences some movement is allowed. Patients are generally required to remain still for only a few seconds to a few minutes at a time.

Depending on the part of the body being examined, a contrast material may be used to enhance the visibility of certain tissues or blood vessels. A small needle connected to an intravenous line is placed in an arm or hand vein. The contrast material is injected about two-thirds of the way through the exam.

When the exam is over the patient is asked to wait until the images are examined to determine if more images are needed.

What will I experience during the procedure?

MRI causes no pain, but some patients can find it uncomfortable to remain still during the examination. Others experience a sense of being "closed in," though the more open construction of newer MRI systems has done much to reduce that reaction. You may notice a warm feeling in the area under examination; this is

normal, but if it bothers you, the radiologist or technologist should be told.

Most bothersome to many patients are the loud tapping or knocking noises heard at certain phases of imaging. Ear plugs may help.

Who interprets the results and how do I get them?

A radiologist, who is a physician experienced in MRI and other radiology examinations, will analyze the images and send a signed report with his or her interpretation to the patient's personal physician. The personal physician's office will inform the patient on how to obtain their results. New technology also allows for distribution of diagnostic reports and referral images over the Internet at some facilities.

What are the benefits vs. risks?

Benefits

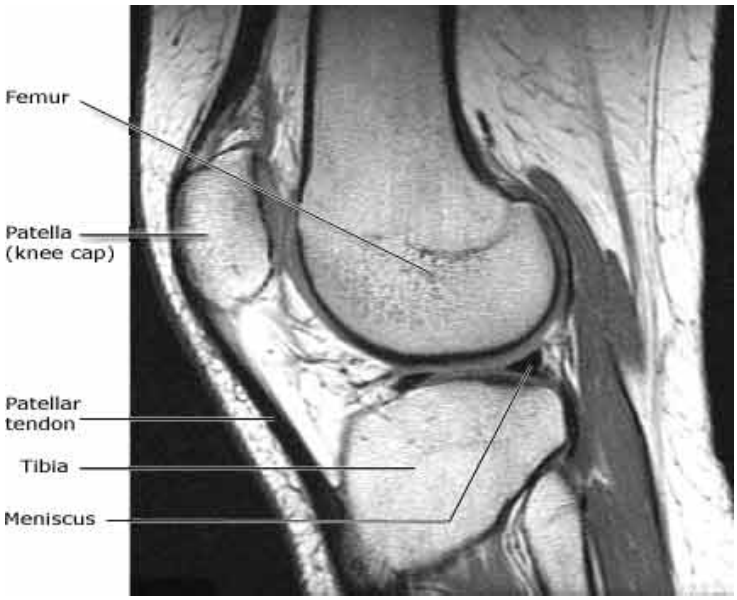
- MR images of the soft tissue structures of the body, such as the muscles, tendons, joints, and blood vessels, are clearer and more detailed than with other imaging methods.
- MR images can help identify the causes of pain, swelling, and bleeding so that appropriate treatment can begin.
- MRI contrast material is less likely to produce an allergic reaction than the iodine-based materials used for conventional x-rays and CT scanning.
- MRI enables the detection of abnormalities, injuries, and diseases that might be obscured by bone tissue with other imaging methods.
- MRI provides a fast, noninvasive way to assess a variety of muscle and joint injuries and disorders.
- The detail of MR images makes them an invaluable tool in early diagnosis and evaluation of tumors.
- Exposure to radiation is avoided.

Risks

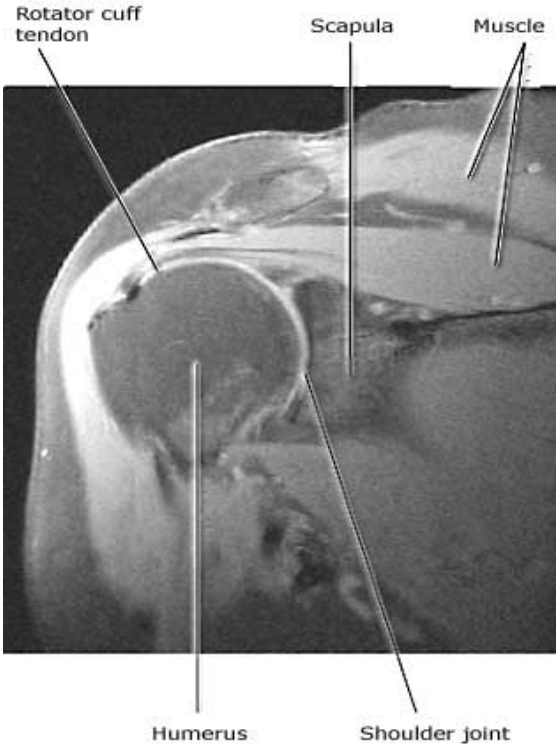
- An undetected metal implant may be affected by the strong magnetic field. It may cause some distortion of the images or the MRI system may have difficulty "tuning" to your body if the implant is in the area being imaged.
- MRI is generally avoided in the first 12 weeks of pregnancy although there are no proven hazards.

What are the limitations of MRI of the Musculoskeletal System?

Bone is better imaged by conventional x-rays, and CT is preferred for unstable patients with severe bleeding. MRI may not always distinguish between tumor tissue and edema fluid, and does not detect calcium when this is present within a tumor. In most cases the exam is safe for patients with metal implants, with the exception of a few types of implants, so patients should inform the technician of an implant prior to the test. The exam must be used cautiously in early pregnancy.



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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