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Magnetic Resonance Imaging (MRI) - Spine

Magnetic resonance imaging (MRI) of the spine uses radio waves, a magnetic field and a computer to produce detailed pictures of the spine and surrounding tissues that are clearer and more detailed than other imaging methods. The exam does not use ionizing radiation and may require an injection of a contrast material called gadolinium, which is less likely to cause an allergic reaction than iodinated contrast material.

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 Spine?

Magnetic resonance imaging (MRI) is a noninvasive medical test that physicians use to diagnose medical conditions.

MRI uses a powerful magnetic field, radio frequency pulses and a computer to produce detailed pictures of organs, soft tissues, bone and virtually all other internal body structures. MRI does not use ionizing radiation (x-rays).

Detailed MR images allow physicians to evaluate various parts of the body and determine the presence of certain diseases. The images can then be examined on a computer monitor, transmitted electronically, printed or copied to a CD or uploaded to a digital cloud server.

An MRI examination of the spine shows the anatomy of the vertebrae that make up the spine, ligaments that hold the vertebrae together, as well as the disks, spinal cord and the spaces between the vertebrae through which nerves pass.

Currently, MRI is the most sensitive imaging test of the spine in routine clinical practice.

What are some common uses of the procedure?

MR imaging is performed to:

- assess spinal anatomy and alignment.
- detect congenital anomalies of vertebrae or the spinal cord.
- detect bone, disc, ligament or spinal cord injury after spine trauma.
- assess intervertebral disk disease (degenerated, bulging or herniated) and intervertebral joint disease, both frequent causes of severe lower back pain and sciatica (back pain radiating into lower leg).
- explore other possible causes of back pain (compression fracture or bone swelling, such as edema).
- assess compression of spinal cord and nerves.
- assess inflammation of the spinal cord or nerves.
- assess infection involving the spine, disks and spinal contents including spinal cord or its coverings (meninges).
- assess tumors that arise from or have spread to the vertebrae, spinal cord, nerves or the surrounding soft tissues.
- help plan spinal surgical procedures, such as decompression of a pinched nerve, spinal fusion, or the injection of steroids to relieve spinal pain. Such injections are usually performed under CT guidance.
- monitor changes in the spine after an operation, such as scarring or infection.

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 with the specific exam and with the imaging facility. Unless you are told otherwise, you may follow your regular daily routine and take food and medications as usual.

Some MRI examinations may require you to receive an injection of contrast material into the bloodstream. The radiologist, technologist or a nurse may ask if you have allergies of any kind, such as an allergy to iodine or x-ray contrast material, drugs, food, or the environment, or if you have asthma. The contrast material most commonly used for an MRI exam contains a metal called gadolinium. Gadolinium can be used in patients with iodine contrast allergy. It is far less common for a patient to have an allergy to a gadolinium-based contrast agent used for MRI than the iodine-containing contrast for CT. However,

even if it is known that the patient has an allergy to the gadolinium contrast, it may still be possible to use it after appropriate pre-medication. Patient consent will be requested in this instance. For more information on adverse reactions to gadolinium-based contrast agents, please consult the ACR Manual on Contrast Media.

You should also let the radiologist know if you have any serious health problems, or if you have had any recent surgeries. Some conditions, such as severe kidney disease, may prevent you from being given gadolinium contrast for an MRI. If you have a history of kidney disease or liver transplant, it will be necessary to perform a blood test to determine whether the kidneys are functioning adequately.

Women should always inform their physician or technologist if there is any possibility that they are pregnant. MRI has been used for scanning patients since the 1980s with no reports of any ill effects on pregnant women or their unborn babies. However, because the unborn baby will be in a strong magnetic field, pregnant women should not have this exam in the first three to four months of pregnancy unless the potential benefit from the MRI exam is assumed to outweigh the potential risks. Pregnant women should not receive injections of gadolinium contrast material except when absolutely necessary for medical treatment. See the MRI Safety page for more information about pregnancy and MRI.

If you have claustrophobia (fear of enclosed spaces) or anxiety, you may want to ask your physician for a prescription for a mild sedative prior to your scheduled examination.

Infants and young children usually require sedation or anesthesia to complete an MRI exam without moving. Whether a child requires sedation depends on the child's age, intellectual development and the type of exam. Moderate and conscious sedation can be provided at many facilities. A physician or nurse specializing in sedation or anesthesia for children should be available during the exam for your child's safety. You will be given special instructions for how to prepare your child for the sedation or anesthesia. Alternatively, certain pediatric facilities have child life personnel who can work with younger children to help avoid the need for sedation or anesthesia. They prepare the children for MRI by showing them a dummy scanner, play the noises that the child might hear during the MRI exam, answer any questions and explain the procedure to relieve their anxiety. Some pediatric facilities also provide goggles or headsets so that the child can watch a movie while the scan is being performed. Thus, the child remains motionless allowing for good quality images.

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 items are not allowed in the exam room. In addition to affecting the MRI images, these objects can become projectiles within the MRI scanner room and may cause you and/or others nearby harm. 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

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 scanning area:

- cochlear (ear) implant

- some types of clips used for brain aneurysms
- some types of metal coils placed within blood vessels
- nearly all cardiac defibrillators and pacemakers

You should tell the technologist if you have medical or electronic devices in your body. These objects may interfere with the exam or potentially pose a risk, depending on their nature and the strength of the MRI magnet. Many implanted devices will have a pamphlet explaining the MRI risks for that particular device. If you have the pamphlet, it is useful to bring that to the attention of the scheduler before the exam and bring it to your exam in case the radiologist or technologist has any questions. Some implanted devices require a short period of time after placement (usually six weeks) before being safe for MRI examinations. Examples include but are not limited to:

- artificial heart valves
- implanted drug infusion ports
- artificial limbs or metallic joint prostheses
- implanted nerve stimulators
- metal pins, screws, plates, stents or surgical staples

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

Patients who might have metal objects in certain parts of their bodies may also require an x-ray prior to an MRI. You should notify the technologist or radiologist of any shrapnel, bullets, or other pieces of metal that may be present in your body due to prior accidents. Foreign bodies near and especially lodged in the eyes are particularly important because they may move during the scan, possibly causing blindness. Dyes used in tattoos may contain iron and could heat up during an MRI scan, but this is rare. Tooth fillings and braces usually are not affected by the magnetic field, but they may distort images of the facial area or brain, so you should let the radiologistknow about them.

Parents or family members who accompany patients into the scanning room also need to remove metal objects and notify the technologist of any medical or electronic devices they may have.

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. Some newer MRI machines have a larger diameter bore which can be more comfortable for larger size patients or patients with claustrophobia. Other MRI machines are open on the sides (open MRI). Open units are especially helpful for examining larger patients or those with claustrophobia. Newer open MRI units provide very high quality images for many types of exams. Older open MRI units may not provide this same image quality. Certain types of exams cannot be performed using open MRI. For more information, consult your radiologist.

The computer workstation that processes the imaging information is located in a separate room from the scanner.

How does the procedure work?

Unlike conventional x-ray examinations and computed tomography (CT) scans, MRI does not utilize ionizing radiation. Instead, radiofrequency pulses re-align hydrogen atoms that naturally exist within the body while you are in the scanner without causing any chemical changes in the tissues. As the hydrogen atoms return to their usual alignment, they emit different amounts of energy that vary according to the type of body tissue from which they come. The MR scanner captures this energy and creates a picture of the tissues scanned based on this information.

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

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

Frequently, the differentiation of abnormal (diseased) tissue from normal tissues is better with MRI than with other imaging modalities such as x-ray, CT and ultrasound.

How is the procedure performed?

MRI examinations may be performed on outpatients or inpatients.

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.

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.

Depending on the location of symptoms, only part of the spine may be imaged. For example, the cervical (neck) portion, the thoracic (chest) spine or the lumbar (lower) spine. Intravenously injected contrast material may be used when looking for infection, tumors or recurrent disk issues after a surgery.

If a contrast material will be used in the MRI exam, a physician, nurse or technologist will insert an intravenous (IV) catheter, also known as an IV line, into a vein in your hand or arm. A saline solution may be used to inject the contrast material. The solution will drip through the IV to prevent blockage of the IV catheter until the contrast material is injected.

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

When the examination is complete, you may be asked to wait until the technologist or radiologist 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 30 to 60 minutes, depending on whether the entire length of the spine is scanned or only part of the spine is scanned. If contrast material is used, more images are needed after the injection which adds an additional 15 to 20 minutes to the total scan time.

What will I experience during and after the procedure?

Most MRI exams are painless. However, some patients find it uncomfortable to remain still during MR imaging. Others experience a sense of being closed-in (claustrophobia) while in the MRI scanner. Therefore, sedation can be arranged for those patients who anticipate anxiety, but fewer than one in 20 require medication.

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 obtained, 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 and feel loud tapping or thumping sounds when the coils that generate the radiofrequency pulses are activated. Some centers provide earplugs, while others use headphones to reduce the intensity of the sounds made by the MRI machine. You may be able to relax between imaging sequences, but will be asked to maintain your position without movement as much as possible.

You will usually be alone in the exam room during the MRI procedure. 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 as long as they are also screened for safety in the magnetic environment.

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 you pass the time.

In some cases, intravenous injection of contrast material may be administered before the images are obtained. The intravenous needle may cause you some discomfort when it is inserted and you may experience some bruising. There is also a very small chance of irritation of your skin at the site of the IV tube insertion. Some patients may sense 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, including nausea, headache and pain at the site of injection. Similarly, patients are very rarely allergic to the contrast material and experience hives, itchy eyes or other reactions. If you experience allergic symptoms, notify the technologist. A radiologist or other physician will be available for immediate assistance.

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.

Follow-up examinations may be necessary. Your doctor will explain the exact reason why another exam is requested. 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 examination may also be necessary so that any change in a known abnormality can be monitored over time. Follow-up examinations are sometimes the best way to see if treatment is working or if a finding is stable or changed over time.

What are the benefits vs. risks?

Benefits

- MRI is a noninvasive imaging technique that does not involve exposure to ionizing radiation.
- MR images of the spine are clearer and more detailed than images obtained with other imaging methods. MRI can show abnormalities, injuries and diseases in the spinal region that may not be seen with other imaging methods. MRI is the best available modality to visualize spinal cord and nerves.
- MRI enables the discovery 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 contrast materials used for conventional x-rays and CT scanning.
- MRI is very useful for evaluating spinal injuries. It is especially helpful for diagnosing or ruling out acute compression of the spinal cord when the clinical examination shows muscle weakness or paralysis. MRI is the best modality available for evaluation of ligament injuries.
- MRI is able to detect subtle changes in the vertebral column that may be an early stage of infection or tumor. The procedure is more sensitive than CT scanning for evaluating tumors, abscesses and other soft tissue masses near the spinal cord.
- MRI is the preferred technique in evaluating for potential complications of surgery, including bleeding, scarring, infection and re-appearance of a herniated disk.

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. However, the technologist or nurse will monitor your vital signs to minimize this risk.
- Although the strong magnetic field is not harmful in itself, implanted medical devices that contain metal may malfunction or cause problems during an MRI exam.
- Nephrogenic systemic fibrosis is currently a recognized, but rare, complication of MRI believed to

be caused by the injection of high doses of gadolinium-based contrast material in patients with very poor kidney function. Careful assessment of kidney function before considering a contrast injection minimizes the risk of this very rare complication.

- There is a very slight risk of an allergic reaction if contrast material is injected. Such reactions are usually mild and easily controlled by medication. If you experience allergic symptoms, a radiologist or other physician will be available for immediate assistance.
- Manufacturers of intravenous contrast indicate mothers should not breastfeed their babies for 24-48 hours after contrast medium is given. However, both the American College of Radiology (ACR) and the European Society of Urogenital Radiology note that the available data suggest that it is safe to continue breastfeeding after receiving intravenous contrast. For further information please consult the ACR Manual on Contrast Media and its references.

What are the limitations of MRI of the Spine?

High-quality images are assured only if you are able 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 the opening of certain types of MRI machines.

The presence of an implant or other metallic object sometimes makes it difficult to obtain clear images due to streak artifacts from the metallic objects. Patient movement can have the same effect.

A very irregular heartbeat may affect the quality of images obtained using techniques that time the imaging based on the electrical activity of the heart, such as electrocardiography (EKG).

MRI generally is not recommended for patients who have been acutely injured; however, this decision is based on clinical judgment. This is because traction devices and many types of life support equipment may distort the MR images and as a result, 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, pregnant women usually are advised not to have an MRI exam during the first trimester unless medically necessary.

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

In some patients, vertebral fractures may be better detected by CT scan.

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