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For patients

Functional MRI (fMRI)

Functional magnetic resonance imaging (fMRI) measures the small changes in blood flow that occur with brain activity. It may be used to examine which parts of the brain are handling critical functions, evaluate the effects of stroke or other disease, or to guide brain treatment. fMRI may detect abnormalities within the brain that cannot be found with other imaging techniques.

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 and stents 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 and try to maintain your typical habits for drinking caffeinated beverages (especially coffee). For example, if you normally drink coffee every morning, try not to skip it on the day of your exam. If you rarely drink coffee, try to avoid it on the day of your exam. Leave jewelry at home and wear loose, comfortable clothing. You may need to change into a gown for the procedure.

What is functional MRI (fMRI)?

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

MRI uses a powerful magnetic field, radiofrequency pulses, and a computer to produce detailed pictures of internal body structures. MRI does not use radiation (x-rays).

Detailed MR images allow doctors to examine the body and detect disease.

Functional magnetic resonance imaging (fMRI) uses MR imaging to measure the tiny changes in blood flow that take place when a certain part of your brain is working.

What are some common uses of the procedure?

Doctors use fMRI to learn how a normal, diseased or injured brain is working. They may also use it to assess the potential risks of surgery or other invasive (http://www.radiologyinfo.org) brain treatments. While doctors may use fMRI to research many conditions, the FDA has only approved the use of fMRI for surgical planning.

Your doctor may order an fMRI to:

- Determine which part of the brain is handling critical functions such as thought, speech, movement and sensation, which is called brain mapping (http://www.radiologyinfo.org) . Studying which parts of the brain are involved in certain functions of our body is called functional anatomy.
- Monitor the growth and function of brain tumors (https://www.radiologyinfo.org/en/info/braintumor) .
- Guide the planning of surgery, radiation therapy (http://www.radiologyinfo.org) , or other invasive treatments for the brain,

by determining which brain functions – such as language or movement – may be affected by treatment.

How should I prepare?

Most MRI facilities will ask you to change into a hospital gown or scrubs before your MRI.

Guidelines about eating and drinking before an MRI vary between specific exams and facilities. Take food and medications as usual unless your doctor or the MRI facility tells you otherwise.

Tell the technologist or radiologist if you have any serious health problems or recent surgeries.

Many fMRI centers will perform a screening of your language or motor skills to determine what tasks are optimal for you to perform in the scanner. Tell the technologist if you are bilingual, as some centers will perform testing in multiple languages.

You need to stay awake and perform tasks during an fMRI exam. Do not take sedatives or similar medications that will make you sleepy during your scan.

Patients should always tell their doctor and technologist if they are pregnant. MRI has been used since the 1980s with no reports of any ill effects on pregnant patients or their unborn babies. However, the baby will be in a strong magnetic field. Therefore, pregnant patients should not have an MRI in the first trimester unless the benefit of the exam clearly outweighs any potential risks. Pregnant patients should not receive gadolinium contrast unless absolutely necessary. *See the MRI Safety During Pregnancy (https://www.radiologyinfo.org/en/info/safety-mri-pregnancy) page for more information about pregnancy and MRI.*

Leave all jewelry and other accessories at home or remove them prior to the MRI scan. Metal and electronic items are not allowed in the exam room. They can interfere with the magnetic field of the MRI unit, cause burns, or become harmful projectiles. 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
- magnetic eyelashes
- pens, pocketknives, and eyeglasses
- body piercings
- mobile phones, electronic watches, and tracking devices.

In most cases, an MRI exam is safe for patients with metal implants, except for a few types. People with the following implants may not be scanned and should not enter the MRI scanning area without first being evaluated for safety:

- some cochlear (ear) implants
- some types of clips used for brain aneurysms (http://www.radiologyinfo.org)
- some older cardiac defibrillators (http://www.radiologyinfo.org) and pacemakers (http://www.radiologyinfo.org)
- vagal nerve stimulators

Tell the technologist if you have medical or electronic devices in your body. These devices may interfere with the exam or pose a risk. Many implanted devices will have a pamphlet explaining the MRI risks for that device. If you have the pamphlet, bring it to the attention of the scheduler before the exam. MRI cannot be performed without confirmation and documentation of the type of implant and MRI compatibility. You should also bring any pamphlet to your exam in case the radiologist or technologist has any questions.

If there is any question, an x-ray can detect and identify any metal objects. Metal objects used in orthopedic surgery generally pose

no risk during MRI.

Tell the technologist or radiologist about any shrapnel, bullets, or other metal that may be in your body. Foreign bodies near and especially lodged in the eyes are very important because they may move or heat up during the scan and cause blindness. Dyes used in tattoos may contain iron and could heat up during an MRI scan. This is rare. The magnetic field will usually not affect tooth fillings, braces, eyeshadows, and other cosmetics. However, these items may distort images of the facial area or brain. Tell the radiologist (http://www.radiologyinfo.org) about them. It is best to not wear eye makeup during an MRI and remove any dental hardware or braces that can be easily removed before your MRI.

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 table that slides into a tunnel towards the center of the magnet.

Some MRI units, called short-bore systems (http://www.radiologyinfo.org) , are designed so that the magnet does not completely surround you.

How does the procedure work?

Unlike x-ray and computed tomography (CT) exams, MRI does not use radiation. Instead, radio waves re-align hydrogen atoms that naturally exist within the body. This does not cause any chemical changes in the tissues. As the hydrogen atoms return to their usual alignment, they emit different amounts of energy depending on the type of tissue they are in. The scanner captures this energy and creates a picture using this information.

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

A computer processes the signals and creates a series of images, each of which shows a thin slice of the body. The radiologist can study these images from different angles.

MRI is often able to tell the difference between diseased tissue and normal tissue better than x-ray, CT, and ultrasound.

In an fMRI examination, you will perform one or more tasks during the imaging process, such as tapping your fingers or toes, pursing your lips, wiggling your tongue, reading, viewing pictures, listening to speech and/or playing simple word games. This will cause increased metabolic (http://www.radiologyinfo.org) activity in the areas of the brain responsible for these tasks. This activity, which includes expanding blood vessels, increasing blood flow, and the delivery of extra oxygen, can then be seen on MRI images.

How is the procedure performed?

MRI exams may be done on an outpatient basis.

The technologist will position you on the moveable exam table. They may use straps and bolsters to help you stay still and maintain your position.

The technologist may place devices that contain coils capable of sending and receiving radio waves around or next to the area of the body under examination.

MRI exams generally include multiple runs (sequences), some of which may last several minutes. Each run will create a different set of noises.

For fMRI, your head may be placed in a brace designed to help hold it still. This brace may include a mask that is created especially for you. You may be given special goggles and/or earphones to wear, so that audio-visual stimuli (for example, a projection from a computer screen or recorded sounds) may be administered during the scan. The technician may put additional padding around your head to help you keep still during the exam.

You will be placed into the magnet of the MRI unit. The technologist will perform the exam while working at a computer outside of the room. You will be able to talk to the technologist via an intercom.

When the exam is complete, the technologist may ask you to wait while the radiologist checks the images in case more are needed.

The technologist will remove your IV line after the exam is over and place a small dressing over the insertion site.

The entire examination is usually completed within one hour.

The doctor may also perform MR spectroscopy during your exam. MR spectroscopy provides additional information on the chemicals present in the body's cells. This may add about 15 minutes to the total exam time.

What will I experience during and after the procedure?

Most MRI exams are painless. However, some patients find it uncomfortable to remain still. Others may feel closed-in (claustrophobic) while in the MRI scanner. The scanner can be noisy.

It is normal for the area of your body being imaged to feel slightly warm. 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 minutes at a time. For some types of exams, you may be asked to hold your breath. You will know when images are being recorded because you will hear tapping or thumping sounds when the coils that generate the radiofrequency pulses are activated. You will be able to relax between imaging sequences but will be asked to maintain your position as much as possible.

You will usually be alone in the exam room during the MRI procedure. However, the technologist will always be able to see, hear, and speak with you using a two-way intercom. They will give you a “squeeze-ball” that alerts the technologist that you need attention right away. Many MRI centers allow a friend or parent to stay in the room if they are also screened for safety in the magnetic environment.

The technologist will offer earplugs to reduce the noise of the MRI scanner. The scanner produces loud thumping and humming noises during imaging. MRI scanners are air-conditioned and well-lit. Some scanners have music to help you pass the time.

If contrast material is injected, it is normal to feel coolness and a flushing sensation for a minute or two. The intravenous needle may cause you some discomfort when it is inserted. Once it is removed, you may experience some bruising. There is also a very small chance of skin irritation 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, itchy eyes, or other reactions. If you experience allergic symptoms, a radiologist or other physician will be available for immediate assistance.

Who interprets the results and how do I get them?

A radiologist, neurologist, or neuropsychologist, specifically trained in functional MRI interpretation, will analyze the images. The doctor will 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 a noninvasive imaging technique that does not involve exposure to radiation.
- MRI can help physicians evaluate both the structure of an organ and how it is working.
- MRI can detect abnormalities that might be obscured by bone with other imaging methods.
- fMRI enables the detection of abnormalities of the brain, as well as the assessment of the normal functional anatomy of the brain, which cannot be accomplished with other imaging techniques.

Risks

- The MRI exam poses almost no risk to the average patient when appropriate safety guidelines are followed.
- If sedation is used, there is a risk of using too much. However, your vital signs will be monitored to minimize this risk.
- The strong magnetic field is not harmful to you. However, it may cause implanted medical devices to malfunction or distort the images.

What are the limitations of fMRI?

High-quality images depend on your ability 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.

fMRI is especially sensitive to head motion. It is important to keep relaxed but still during the scan.

fMRI requires that you are able to perform the tasks presented to you. If the tasks are too difficult for you or if you have difficulty performing the actions, you should tell the technologist. They may give you different tasks or easier questions.

A person who is very large may not fit into certain types of MRI machines. There are weight limits on the scanners.

Implants and other metallic objects can make it difficult to obtain clear images. Patient movement can have the same effect.

A very irregular heartbeat may affect the quality of images. This is because some techniques time the imaging based on the electrical activity of the heart.

MRI is generally not recommended for seriously injured patients. However, this decision is based on clinical judgment. This is because traction devices and life support equipment may distort the MR images. As a result, they must be kept away from the area to be imaged. Some trauma patients, however, may need MRI.

Present data show no convincing evidence that non contrast MRI harms the fetus of a pregnant woman. However, if the need for the exam is not time sensitive your doctor may delay the exam until after delivery. MRI gadolinium contrast agents are generally avoided during pregnancy except in very specific circumstances. Your doctor will discuss the benefits and risks of any MRI procedure with you. Doctors may perform MRI after the first trimester to assess the fetus for findings that are not fully evaluated by ultrasound.

An MRI exam typically costs more and may take more time than other imaging exams. Talk to your insurance provider if you have concerns about the cost of MRI.

Functional MRI (http://www.radiologyinfo.org) is still evolving and improving. While it appears to be as accurate in finding the location of brain activity as any other method, overall there is less experience with fMRI than with many other MRI techniques. Your physician may recommend additional tests to confirm the results of fMRI if there are critical decisions to make (such as in planning brain surgery).

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