



MR Angiography (MRA)

MR angiography (MRA) uses a powerful magnetic field, radio waves and a computer to evaluate blood vessels and help identify abnormalities or diagnose atherosclerotic (plaque) disease. This 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. In some instances, your doctor will provide you with a card that includes information about your implant to give to the technologist. 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 MR Angiography?

Angiography is a medical test that helps physicians diagnose and treat medical conditions and diseases of the blood vessels. Angiography examinations produce pictures of major blood vessels throughout the body and can be performed with one of three imaging technologies and, in some cases contrast material is administered.

Angiography is performed using:

- fluoroscopy (x-rays) to help the interventional radiologist place catheters into the blood vessels of the body
- computed tomography (CT)
- magnetic resonance imaging (MRI)

In magnetic resonance angiography (MRA), a powerful magnetic field, radio frequency waves and a computer produce detailed images of the major arteries within the body. MR angiography does not use ionizing radiation (x-rays).

MRA may be performed with or without contrast material. If needed, the contrast material is usually administered through a small intravenous (IV) catheter placed in a vein in your arm.

What are some common uses of the procedure?

MRA is used to examine blood vessels in key areas of the body, including the:

- brain
- neck
- heart
- chest
- abdomen (such as the kidneys and liver)
- pelvis
- legs and feet
- arms and hands

Physicians use the procedure to:

- identify abnormalities, such as aneurysms, in the aorta, both in the chest and abdomen, or in other arteries.
- detect atherosclerotic (plaque) disease in the carotid artery of the neck, which may limit blood flow to the brain and cause a stroke.
- identify a small aneurysm or arteriovenous malformation (abnormal communications between blood vessels) inside the brain or other parts of the body.
- detect atherosclerotic disease that has narrowed the arteries to the legs and help prepare for endovascular intervention or surgery.
- detect disease in the arteries to the kidneys or visualize blood flow to help prepare for a kidney transplant or stent placement.
- guide interventional radiologists and surgeons making repairs to diseased blood vessels, such as implanting stents or evaluating a stent after implantation.
- detect injury to one or more arteries in the neck, chest, abdomen, pelvis or extremities in patients after trauma.
- evaluate arteries feeding a tumor prior to surgery or other procedures such as chemoembolization or selective internal radiation therapy.
- identify dissection or splitting in the aorta in the chest or abdomen or its major branches.
- show the extent and severity of the effects of coronary artery disease and plan for a surgical operation, such as a coronary bypass and stenting.
- examine pulmonary arteries in the lungs to detect pulmonary embolism (blood clots, such as those traveling from leg veins) or pulmonary arteriovenous malformations.
- look at congenital abnormalities in blood vessels, especially arteries in children (e.g., malformations in the heart or other blood vessels due to congenital heart disease).

- evaluate obstructions of vessels.
- screen individuals for arterial disease, especially patients with a family history of arterial disease or disorders.

MRA is also used as a substitute for CT angiography when the use of contrast media is contraindicated.

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.

MRA may require you to receive an injection of contrast into a vein in your arm. The radiologist or technologist may ask if you have asthma or if you have allergies to certain drugs, foods or to the environment. The contrast material used for an MRI exam, called gadolinium, does not contain iodine and is less likely to cause an allergic reaction than iodine containing contrast used for a CT scan.

The radiologist and technologist should also know if you have any serious health problems and what surgeries you have undergone. Some patients with severe kidney or liver disease may not be able to receive contrast material during an MRI exam.

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 are breastfeeding at the time of the exam, you should ask your doctor how to proceed. It may help to pump breast milk ahead of time and keep it on hand for use after contrast material has cleared from your body, about 24 hours after the test.

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 radiologist know about 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. 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. 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 body tissue they are in. 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.

When a contrast material is introduced to the bloodstream during the procedure, it clearly defines the blood vessels being examined by making them appear bright white.

How is it performed?

This examination is 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.

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 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.

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 during or following the injection.

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 in approximately 60 minutes once imaging has started.

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.
- Detailed images of many blood vessels and blood flow can be obtained without having to insert an IV catheter into the blood vessels. When needed, a small IV catheter is inserted into a small vein in the arm so that there is no risk of damaging a major blood vessel as it is a less invasive procedure.
- The MRA procedure time may be shorter than a traditional catheter angiography and requires no recovery period. You may return to your normal daily activities immediately following the MRA examination.
- MR angiography is less costly than catheter angiography.
- Even without using contrast material, MRA can provide useful high-quality images of many blood vessels, making it very valuable for patients prone to allergic reactions or with reduced kidney or liver function.
- 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.

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 MR Angiography?

Unlike CT angiography, MRA is not able to see and capture images of calcium deposits within the blood vessels.

The clarity of MRA images of some arteries does not match those obtained with conventional catheter-based angiography. MRA evaluation of small vessels, in particular, may be difficult. Sometimes it may be difficult to create separate images of arteries and veins with MRA.

Individuals who have difficulty remaining still or lying on their back may have MRA images that are of poor quality. Some tests involve monitoring the heart beat or require patients to hold their breath for 15 to 25 seconds at a time in order to get high quality MRA pictures. Any type of motion, such as patient movement, breathing motion, or other involuntary movements can significantly decrease the image quality and potentially limit diagnosis.

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).

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.

Contrast injections during pregnancy are usually avoided except when absolutely necessary for medical treatment.

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