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For patients

MR Angiography (MRA)

MR angiography (MRA) uses a powerful magnetic field, radio waves and a computer to evaluate blood vessels and help identify abnormalities. This exam does not use radiation and may require an injection of contrast material. The contrast material used for MRA is less likely to cause an allergic reaction than the contrast material used for computed tomography (CT).

Tell your doctor about any health problems, recent surgeries, allergies and whether 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. Sometimes, your doctor will give you a card with information about your implant. Give this to the technologist. Guidelines about eating and drinking before your exam vary between facilities. Unless your doctor tells you 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 a fear of close spaces or anxiety, consider asking your doctor for a mild sedative prior to the exam.

What is MR Angiography?

Doctors use angiography to diagnose and treat blood vessel-related diseases. Angiography exams produce pictures of major blood vessels throughout the body. In some cases, contrast material is used.

Doctors perform angiography using:

- fluoroscopy (x-rays) to help place catheters into blood vessels and inject contrast to help visualize them
- computed tomography (CT)
- magnetic resonance imaging (MRI)

In magnetic resonance angiography (MRA), a powerful magnetic field, radio frequency waves and a computer are used to evaluate blood vessels and help identify abnormalities. This exam, like all MR-based exams, does not use radiation.

An MRA exam may or may not use contrast material. If needed, an injection of a gadolinium-based contrast material may be used. Gadolinium is less likely to cause an allergic reaction than the iodinated contrast material used in CT angiography. The doctor or the technologist will usually administer the contrast material by placing a small intravenous (IV) catheter in a vein in your arm.

What are some common uses of the procedure?

Doctors use MRA to examine blood vessels in key areas, including the:

- brain
- neck
- heart
- chest

- abdomen (such as the kidneys and liver)
- pelvis
- legs and feet
- arms and hands

Doctors use MRA 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 arteriovenous malformation inside the brain or elsewhere.
- detect plaque disease that has narrowed the arteries to the legs and help prepare for angioplasty/stent placement 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 limbs following 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 coronary artery disease and its effects and plan for an intervention, such as a coronary bypass and stenting.
- examine pulmonary arteries in the lungs to detect pulmonary embolism (https://www.radiologyinfo.org/en/info/pulmonary-embolism) (blood clots, such as those traveling from leg veins) or pulmonary AVMs.
- 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 stenosis and obstructions of vessels.
- screen individuals for arterial disease, especially patients with a family history of it.

MRA is also used as a substitute for CT angiography when iodinated contrast material cannot be used.

How should I prepare?

You may wear a gown during the exam or 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 your doctor says otherwise, follow your regular daily routine and take medications as usual.

MRA may require an injection of contrast into a vein in your arm. The radiologist or technologist may ask if you have asthma or allergies to certain drugs, foods or the environment. Doctors may use gadolinium-based contrast material for MRI exams. It does not contain iodine, and it is less likely to cause an allergic reaction than CT and X-ray iodine based contrast.

Tell the radiologist and technologist about any serious health problems and what surgeries you have had. Some patients with severe kidney or liver disease may not be able to receive contrast material during an MRI exam.

Women 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 women or their unborn babies. However, the baby will be in a strong magnetic field. Therefore, pregnant women should not have an MRI in the first trimester unless the benefit of the exam clearly outweighs any potential risks.

Pregnant women 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.*

If you are breastfeeding at the time of the exam, ask your doctor how to proceed. It may help to pump breast milk ahead of time. Keep it on hand for use until all contrast material has cleared from your body (about 24 hours after the test). However, the most recent American College of Radiology (ACR) Manual on Contrast Media reports that studies show the amount of contrast absorbed by the infant during breastfeeding is extremely low. *For further information please consult the ACR Manual on Contrast Media (https://www.acr.org/Clinical-Resources/Contrast-Manual) and its references.*

If you have claustrophobia (fear of enclosed spaces) or anxiety, ask your doctor to prescribe a mild sedative prior to the date of your exam.

Infants and young children often require sedation or anesthesia to complete an MRI exam without moving. This depends on the child's age, intellectual development, and the type of exam. Sedation can be provided at many facilities. A specialist in pediatric sedation or anesthesia should be available during the exam for your child's safety. You will be told how to prepare your child. Some facilities may have personnel who work with children to help avoid the need for sedation or anesthesia. They may prepare children by showing them a model MRI scanner and playing the noises they might hear during the exam. They also answer any questions and explain the procedure to relieve anxiety. Some facilities also provide goggles or headsets so the child can watch a movie during the exam. This helps the child stay still and allows for good quality images.

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
- 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
- some types of metal coils placed within blood vessels
- some older cardiac defibrillators and pacemakers
- 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. However, a recently placed artificial joint may require the use of a different imaging exam.

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 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 table that slides into a tunnel towards 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 patients or those with claustrophobia. "Open" MRI units are open on the sides. They are especially helpful for examining larger patients or those with claustrophobia. Open MRI units can provide high quality images for many types of exams. Open MRI may not be used for certain exams. For more information, consult your radiologist.

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.

Procedures use contrast material to clearly define the blood vessels being examined by making them appear bright white.

How is MRA performed?

This examination is usually 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.

If your exam uses a contrast material, a doctor, nurse, or technologist will insert an intravenous catheter (IV line) into a vein in your hand or arm. They will use this IV to inject the contrast material.

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.

If your exam uses a contrast material, the technologist will inject it into the intravenous line (IV) after an initial series of scans. They will take more images during or following the injection.

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 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. 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, tell the radiologist or technologist. It is important that you remain perfectly still while the images are being taken. This 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. The coils that generate the radio waves make these sounds when they are activated. You will be provided with earplugs or headphones to reduce the noise made by the scanner. You may be able to relax between imaging sequences. However, you will need to keep the same position as much as possible without moving.

You will usually be alone in the exam room. However, the technologist will be able to see, hear, and speak with you at all times using a two-way intercom. They will give you a “squeeze-ball” that alerts the technologist that you need attention right away. Many facilities allow a friend or parent to stay in the room if they have also been screened for safety.

Children will be given appropriately sized earplugs or headphones during the exam. Music may be played through the headphones to help pass the time. MRI scanners are air-conditioned and well-lit.

In some cases, IV injection of contrast material may be given before the images are obtained. The IV needle may cause you some discomfort and you may experience some bruising. There is also a very small chance of skin irritation at the site of the IV tube insertion. Some patients may have 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. These may include nausea, headache, and pain at the site of injection. It is very rare that patients experience hives, itchy eyes, or other allergic reactions to the contrast material. If you have allergic symptoms, tell the technologist. A radiologist or other doctor will be available for immediate assistance.

Who interprets the results and how do I get them?

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

You may need a follow-up exam. If so, your doctor will explain why. Sometimes a follow-up exam further evaluates a potential issue with more views or a special imaging technique. It may also see if there has been any change in an issue over time. Follow-up exams are often the best way to see if treatment is working or if a problem needs attention.

What are the benefits vs. risks?

Benefits

- MRI is a noninvasive imaging technique that does not involve exposure to 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.
- An MRA scan may take less time than traditional catheter angiography and requires no recovery period, unless sedation was provided. If no sedation was used, you may return to your normal daily activities immediately following the MRA exam.
- MR angiography is less costly than catheter angiography.
- Even without using contrast material, MRA can provide useful high-quality images of many blood vessels. This makes it very valuable for patients prone to allergic reactions or with reduced kidney or liver function.
- The MRI gadolinium contrast material is less likely to cause an allergic reaction than the iodine-based contrast materials used for x-rays and CT scanning.

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.
- Nephrogenic systemic fibrosis is a recognized complication related to injection of gadolinium contrast. It is exceptionally rare with the use of newer gadolinium contrast agents. It usually occurs in patients with serious kidney disease. Your doctor will carefully assess your kidney function before considering a contrast injection.
- There is a very slight risk of an allergic reaction if your exam uses contrast material. Such reactions are usually mild and controlled by medication. If you have an allergic reaction, a doctor will be available for immediate assistance.
- Although there are no known health effects, evidence has shown that very small amounts of gadolinium can remain in the body, particularly the brain, after multiple MRI exams. This is most likely to occur in patients receiving multiple MRI exams over their lifetime for monitoring chronic or high-risk health conditions. The contrast agent is mostly eliminated from the body through the kidneys. If you are a patient in this category, consult with your doctor about the possibility of gadolinium retention, as this effect varies from patient to patient.
- IV contrast manufacturers indicate mothers should not breastfeed their babies for 24-48 hours after contrast material is given. However, the most recent American College of Radiology (ACR) Manual on Contrast Media reports that studies show the amount of contrast absorbed by the infant during breastfeeding is extremely low. *For further information please consult the ACR Manual on Contrast Media (https://www.acr.org/Clinical-Resources/Contrast-Manual) 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.

MRA images of some arteries may not be as clear as catheter angiography images. 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.

Patients who cannot lay still or on their backs may have poor quality MRA images. Some tests involve monitoring the heartbeat or require patients to hold their breath for 15 to 25 seconds at a time in order to get high quality pictures. Any type of motion, such as patient movement, breathing motion, cardiac motion, or other involuntary movements can decrease the image quality and potentially limit diagnosis.

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.

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.

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.

Doctors usually avoid contrast injections during pregnancy unless they are absolutely necessary for medical treatment.

Which test, procedure or treatment is best for me?

- *Cerebrovascular Diseases-Aneurysm, Vascular Malformation, and Subarachnoid Hemorrhage (https://www.radiologyinfo.org/en/info/acs-cerebrovascular-diseases)*
- I (http://www.radiologyinfo.org/sitecore/service/notfound.aspx?item=web%3a%7bF3364257-1722-4666-BD00-F67C1044B245%7d%40en#4170dd37d57443dd8f60ab60d15a2683) *liac Artery Occlusive Disease (https://www.radiologyinfo.org/en/info/acs-iliac-artery-occlusive)*
- *Imaging of Deep Inferior Epigastric Arteries for Surgical Planning (Breast Reconstruction Surgery) (https://www.radiologyinfo.org/en/info/acs-imaging-deep-inferior-epigastric-arteries)* (http://www.radiologyinfo.org/sitecore/service/notfound.aspx?item=web%3a%7bF3364257-1722-4666-BD00-F67C1044B245%7d%40en#34166a6a7695406e8acd976a087c3a52)
- *Neck Mass/Adenopathy (https://www.radiologyinfo.org/en/info/acs-neck-mass-adenopathy)*
- *Transcatheter Aortic Valve Replacement (https://www.radiologyinfo.org/en/info/acs-transcatheter-aortic-valve-replacement)*

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