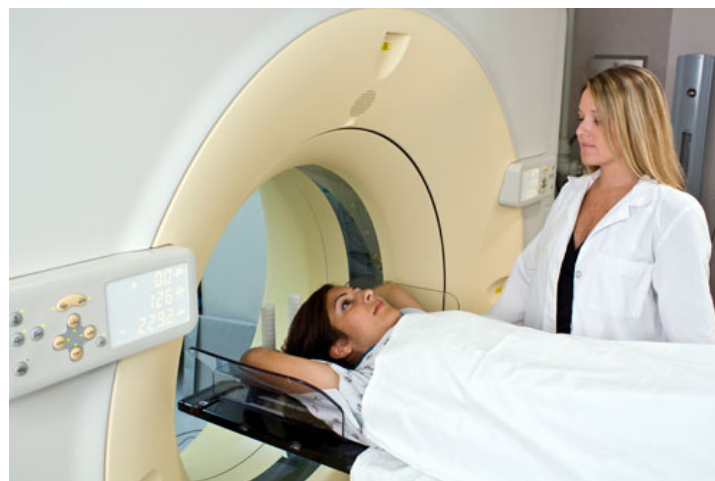




## CT Angiography (CTA)

Computed tomography angiography (CTA) uses an injection of iodine-rich contrast material and CT scanning to help diagnose and evaluate blood vessel disease or related conditions, such as aneurysms or blockages.

Tell your doctor if there's a possibility you are pregnant and discuss any recent illnesses, medical conditions, medications you're taking, and allergies. You will be instructed to not eat or drink anything several hours beforehand. If you have a known allergy to contrast material, your doctor may prescribe medications to reduce the risk of an allergic reaction. These medications must be taken 12 hours prior to your exam. Leave jewelry at home and wear loose, comfortable clothing. You may be asked to wear a gown. If you are breastfeeding, talk to your doctor about how to proceed.



## What is CT Angiography?

Angiography is a minimally invasive medical test that helps physicians diagnose and treat medical conditions. Angiography uses one of three imaging technologies and, in most cases, a contrast material injection is needed to produce pictures of blood vessels in the body.

Angiography is performed using:

- x-rays with catheters
- computed tomography (CT)
- magnetic resonance imaging (MRI)

CT angiography uses a CT scanner to produce detailed images of both blood vessels and tissues in various parts of the body. An iodine-rich contrast material (dye) is usually injected through a small catheter placed in a vein of the arm. A CT scan is then performed while the contrast flows through the blood vessels to the various organs of the body. After scanning, the images will be processed using a special computer and software and reviewed in different planes and projections.

## What are some common uses of the procedure?

CT angiography is used to examine blood vessels and the organs supplied by them in various body parts, including:

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

Physicians use this test to diagnose and evaluate many diseases of blood vessels and related conditions such as:

- injury
- aneurysms
- blockages (including those from blood clots or plaques)
- disorganized blood vessels and blood supply to tumors
- congenital (birth related) abnormalities of the heart, blood vessels or various parts of the body which might be supplied by abnormal blood vessels

Also, physicians use this exam to check blood vessels following surgery, such as:

- 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.

## How should I prepare?

You should wear comfortable, loose-fitting clothing to your exam. You may be given a gown to wear during the procedure.

Metal objects, including jewelry, eyeglasses, dentures and hairpins, may affect the CT images and should be left at home or removed prior to your exam. You may also be asked to remove hearing aids and removable dental work. Women will be asked to remove bras containing metal underwire. You may be asked to remove any piercings, if possible.

You will be asked not to eat or drink anything for a few hours beforehand, if contrast material will be used in your exam. You should inform your physician of all medications you are taking and if you have any allergies. If you have a known allergy to contrast material, or "dye," your doctor may prescribe medications (usually a steroid) to reduce the risk of an allergic reaction. These medications generally need to be taken 12 hours prior to administration of contrast material. To avoid unnecessary delays, contact your doctor before the exact time of your exam.

Also inform your doctor of any recent illnesses or other medical conditions and whether you have a history of heart disease, asthma, diabetes, kidney disease or thyroid problems. Any of these conditions may increase the risk of an unusual adverse effect.

Women should always inform their physician and the CT technologist if there is any possibility that they may be pregnant. See the Safety page for more information about pregnancy and x-rays.

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.

## What does the equipment look like?

The CT scanner is typically a large, box-like machine with a hole, or short tunnel, in the center. You will lie on a narrow examination table that slides into and out of this tunnel. Rotating around you, the x-ray tube and electronic x-ray detectors are located opposite each other in a ring, called a gantry. The computer workstation that processes the imaging information is located in a separate control room, where the technologist operates the scanner and monitors your examination in direct visual contact and usually with the ability to hear and talk to you with the use of a speaker and microphone.

## How does the procedure work?

In many ways, CT scanning works very much like other x-ray examinations. X-rays are a form of radiation—like light or radio waves—that can be directed at the body. Different body parts absorb the x-rays in varying degrees.

In a conventional x-ray exam, a small amount of radiation is aimed at and passes through the body, recording an image on a special image recording plate. Bones appear white on the x-ray; soft tissue, such as organs like the heart or liver, shows up in shades of gray and air appears black.

With CT scanning, numerous x-ray beams and a set of electronic x-ray detectors rotate around you, measuring the amount of radiation being absorbed throughout your body. At the same time, the examination table is moving through the scanner, so that the x-ray beam follows a spiral path. A special computer program processes this large volume of data to create two-dimensional cross-sectional images (slices) of your body, which are then displayed on a monitor. This technique is called helical or spiral CT.

CT imaging is sometimes compared to looking into a loaf of bread by cutting the loaf into thin slices. When the image slices are reassembled by computer software, the result is a very detailed three-dimensional (3-D) view of the body's interior.

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 the procedure performed?

Prior to, or on the day of the procedure, you may be asked to complete a questionnaire to ensure your safety during this procedure. Before the procedure, a nurse or technologist will insert an intravenous (IV) catheter into a vein, usually in your arm or hand. Rarely, a small amount of blood may be withdrawn through the catheter or finger stick to test your kidney function.

The technologist begins by positioning you on the CT examination table, usually lying flat on your back. Straps and pillows may be used to help you maintain the correct position and to help you remain still during the exam.

An automatic injection pump connected to the IV will give contrast material at a controlled rate. In some cases, especially in children and patients with fragile and small veins, the contrast is hand-injected using a syringe. A small amount of contrast material may initially be injected through the IV to determine how long it will take for the contrast to reach the body part that is being evaluated. During scanning, the table is positioned at the start point of imaging and will then move relatively rapidly through the opening of the machine as the actual CT scanning is performed. With some new scanners, if the area to be scanned is limited, like the heart or the chest of a baby, the entire scan may be completed with a single rotation without any table movement.

During CT angiography of the coronary arteries or aorta in the chest, electrocardiogram (ECG) leads (sticky patches) will be placed on your chest to record heart rhythm during scanning. Depending upon how fast and regular your heart beats, your heart rate may be temporarily slowed down for the duration of

the exam with medication to obtain motion free images of the heart. If heart rate medication is given, you will be monitored during and for a brief period after the procedure.

You may be asked to hold your breath during the scanning. Any motion, whether breathing or body movements, can lead to artifacts on the images. This loss of image quality can resemble the blurring seen on a photograph taken of a moving object.

Occasionally, sedation may be needed for children to keep them still during scanning. This usually needs to be prearranged when the CT scan is scheduled as there will be special instructions. For example, eating and drinking may be stopped for a longer duration prior to the exam to prevent complications such as aspiration, and longer monitoring following the scan may be required while the medication used for sedation wears off.

When the examination is completed, you will be asked to wait until the technologist verifies that the images are of high enough quality for accurate interpretation.

Following the exam, the intravenous catheter will be removed. A bandage will be placed over the needle puncture site.

The entire CT angiography exam may be completed within a few seconds. Your actual time in the scanner room will be longer as the technologist will have to appropriately position you on the table, check or place an IV line, do preliminary imaging to verify the beginning and end points of the exam, and set up the scanner and contrast injection pump settings based on the part of the body being imaged.

CT angiography may be performed in children. Since children are more sensitive to radiation than adults, the scan is usually performed with an appropriate amount of radiation delivered for the size of the child. For children and adults of reproductive age, radiation protective shields are used for protection to reproductive parts. Depending upon the body part being examined, thyroid gland radiation protective shields may also be used.

## **What will I experience during and after the procedure?**

CT exams are generally painless, fast and easy. With multidetector CT, the amount of time that the patient needs to lie still is reduced.

Though the scanning itself causes no pain, there may be some discomfort from having to remain still for several minutes and with placement of an IV. If you have a hard time staying still, are very nervous or anxious or have chronic pain, you may find a CT exam to be stressful. The technologist or nurse, under the direction of a physician, may offer you some medication to help you tolerate the CT scanning procedure.

For exams (excluding head and neck) your head will remain outside the hole in the center of the scanner. The scanner is approximately 24 inches wide, therefore, your entire body will be "inside" the scanner at one time such as with MRI.

If an intravenous contrast material is used, you will feel a pin prick when the needle is inserted into your vein. You will likely have a warm, flushed sensation during the injection of the contrast materials and a metallic taste in your mouth that lasts for at most a minute or two. You may experience a sensation like

you have to urinate; however, this is actually a contrast effect and subsides quickly.

When you enter the CT scanner, special light lines may be seen projected onto your body, and are used to ensure that you are properly positioned. With modern CT scanners, you will hear only slight buzzing, clicking and whirring sounds as the CT scanner's internal parts, not usually visible to you, revolve around you during the imaging process.

You will be alone in the exam room during the CT scan, unless there are special circumstances. For example, sometimes a parent wearing a lead shield may stay in the room with their child. However, the technologist will always be able to see, hear and speak with you through a built-in intercom system.

After a CT exam, the intravenous line used to inject the contrast material will be removed by the technologist, and the tiny hole made by the needle will be covered with a small dressing. You can return to your normal activities.

## Who interprets the results and how do I get them?

A radiologist with expertise in supervising and interpreting radiology examinations will analyze the images and send an official report to your primary care physician or physician who referred you for the exam, who will discuss 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

- Angiography may eliminate the need for surgery. If surgery remains necessary, it can be performed more accurately.
- CT angiography is able to detect narrowing or obstruction of blood vessels allowing for potentially corrective therapy to be done.
- CT angiography may give more precise anatomical detail than magnetic resonance imaging (MRI), particularly in small blood vessels.
- Many patients can undergo CT angiography instead of a conventional catheter angiography (catheterization) to diagnose blood vessel problems.
- Compared to catheter angiography which involves placing a catheter (plastic tube), usually at the groin, into your major blood vessels and injecting contrast material, and may require sedation or general anesthesia, CT angiography is faster, non-invasive and has less complications.
- CT angiography is a useful way of detecting arterial (such as narrowing of blood vessels in the



heart) and venous disease as well as structural abnormalities of the heart before there are symptoms or when symptoms are not clearly related to blood vessel disease, such as a heart attack.

- CT angiography is a lower cost examination compared to catheter angiography.
- There is also potentially less discomfort because contrast material is injected into an arm vein rather than into a catheter inserted into a large artery or vein.
- No radiation remains in a patient's body after a CT examination.
- X-rays used in CT scans should have no immediate side effects.

## Risks

Most patients complete CT angiography with no adverse events.

- There is always a slight chance of cancer from excessive exposure to radiation. However, the benefit of an accurate diagnosis far outweighs the risk.
- If you have a history of allergy to x-ray contrast material, your doctor may advise you to take special precautionary medication, such as a steroid, for a few hours or the day before CT angiography to lessen the chances of allergic reaction. Another option is to undergo a different exam that does not require iodinated contrast material.
- In patients who are at risk for kidney failure and who already have borderline kidney function, administering iodinated contrast material could potentially further damage kidney function. Check with your referring doctor and radiologist to obtain more information regarding this risk.
- If a large amount of x-ray contrast material leaks out from the vein being injected and spreads under the skin where the IV is placed, it may damage the skin, blood vessels and nerves. If you feel any pain or tingling sensation in this area during or immediately after the contrast material injection, you should immediately inform the nurse/technologist.
- Women should always inform their physician and x-ray or CT technologist if there is any possibility that they are pregnant. See the Safety page for more information about pregnancy and x-rays.
- 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.
- The risk of serious allergic reaction to contrast materials that contain iodine is extremely rare, and hospitals are well-equipped to deal with them.

## A Word About Minimizing Radiation Exposure

Special care is taken during x-ray examinations to use the lowest radiation dose possible while producing the best images for evaluation. National and international radiology protection organizations continually review and update the technique standards used by radiology professionals.

Modern x-ray systems have very controlled x-ray beams and dose control methods to minimize stray (scatter) radiation. This ensures that those parts of a patient's body not being imaged receive minimal radiation exposure.

Every effort will be made to reduce radiation while performing CT angiography, including tailoring the scan parameters specifically to your body type and weight. The scanning area will also be limited to the

area of interest to avoid unnecessary radiation to other body parts.

## What are the limitations of CT Angiography?

A person who is very large may not fit into the opening of a conventional CT scanner or may be over the weight limit—usually 450 pounds—for the moving table.

CT angiography should be avoided in patients with a previous severe reaction to contrast material, advanced kidney disease or severe diabetes, because x-ray iodine-rich contrast material may be harmful. Also, it may be avoided when the rare and small radiation risk overwhelmingly outweighs the benefits of CT angiography.

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