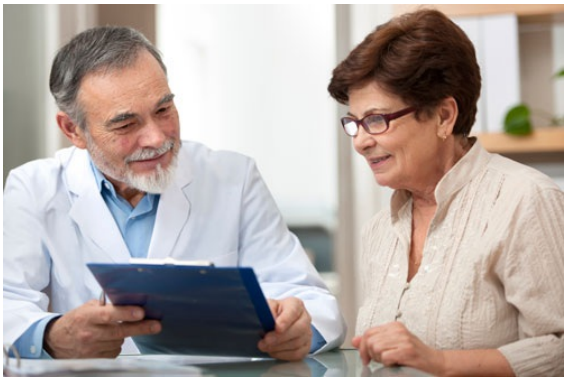
RadiologyInfo.org
For patients

Intracranial Vascular Treatments



Intracranial vascular treatments use imaging guidance such as MRI or angiography and a catheter to improve or block blood flow in the brain's arteries and veins or to deliver focused radiation therapy. They are less invasive than open surgery and can help increase the chance for recovery in acute ischemic stroke patients.

Tell your doctor if there's an possibility you are pregnant and discuss any recent illnesses, medical conditions, allergies and medications you're taking, including herbal supplements and aspirin. You may be advised to stop taking aspirin, nonsteroidal anti-inflammatory drugs (NSAIDs) or blood thinners several days prior to your procedure. You may also be told not to eat or drink anything for several hours before your procedure. Leave jewelry at home and wear loose, comfortable clothing. You may be asked to wear a gown. Talk to your doctor about whether you will be admitted to the hospital or sedated for an outpatient procedure. If so, plan to have someone drive you home afterward.

What are Intracranial Vascular Treatments?

Intracranial vascular treatments are minimally invasive procedures that, depending on the patient's condition, involve image-guided internal catheter navigation of the body's blood vessels to treat vascular conditions affecting the intracranial vessels.

Techniques include:

Endovascular therapy

Endovascular therapy refers to precise treatments involving navigation of blood vessels internally with catheters, such as:

- Embolization: synthetic solid or liquid materials called embolic agents are placed through a catheter into a blood vessel or blood vessel abnormality to prevent blood flow to a specific area. Commonly used embolic agents include coils, Polyvinyl Alcohol Particles, liquid agents that harden (NBCA glue or Onyx), liquid agents that sclerose blood vessels (alcohol), microspheres and Gelfoam.
- Drug delivery: medications are delivered very precisely through a catheter to specific locations in the brain through the blood vessels. These drugs include thrombolytic agents to dissolve clots, drugs to relax blood vessels in spasm, or chemotherapy drugs for cancer.
- Device delivery: permanently implanted or temporary medical devices that are placed through a catheter. These include:
  - Stents: small tubes used to open blood vessels, redirect blood flow or stabilize other devices such as coils.
  - Balloons: devices used to open blood vessels (angioplasty) or assist in the placement of other embolic agents or devices. *See the Angioplasty and Vascular Stenting page (https://www.radiologyinfo.org/en/info/angioplasty) for more information.*
  - Coils: devices that block blood flow. Coils are most commonly used in the treatment of intracranial aneurysms.
- Mechanical retrievers/aspiration systems: used to remove clots or embolic devices or debris.

Stereotactic Radiotherapy

Stereotactic radiosurgery is a precise form of radiation therapy that uses highly focused x-rays to eliminate abnormal blood vessels.

What are some common uses of the procedure?

Intracranial vascular treatments are used to occlude (block) vessels or a blood vessel abnormality. Diseases that are often treated in this manner include:

- arteriovenous malformation (AVM), a tangle of dilated blood vessels that disrupts normal blood flow in the brain.
- arteriovenous fistula (AVF), an abnormal connection or passageway between an artery and a vein.
- intracranial aneurysms, a ballooning out of the wall of an artery inside the brain that can rupture and bleed heavily.
- tumors with excessive blood flow.

These treatments can also be used to improve blood flow, including:

- acute stroke treatment.
- opening narrow blood vessels to prevent stroke.
- treatment of intracranial vasospasm, or tension/contracting of blood vessels.

How should I prepare?

Prior to your procedure, your doctor may test your blood to check your kidney function and to determine if your blood clots normally.

Tell your doctor about all the medications you take, including herbal supplements. List any allergies, especially to local anesthetic, general anesthesia, or contrast materials. Your doctor may tell you to stop taking aspirin, nonsteroidal anti-inflammatory drugs (NSAIDs) or blood thinners before your procedure.

Tell your doctor about recent illnesses or other medical conditions.

Women should always tell their doctor and technologist if they are pregnant. Doctors will not perform many tests during pregnancy to avoid exposing the fetus to radiation. If an x-ray is necessary, the doctor will take precautions to minimize radiation exposure to the baby. *See the Safety in X-ray, Interventional Radiology and Nuclear Medicine Procedures page (https://www.radiologyinfo.org/en/info/safety-radiation) for more information about pregnancy and x-rays.*

You will receive specific instructions on how to prepare, including any changes you need to make to your regular medication schedule.

Other than medications, your doctor may tell you to not eat or drink anything for several hours before your procedure.

The nurse will give you a gown to wear during the procedure.

Endovascular procedures:

You should plan to stay overnight at the hospital for one or more days.

Stereotactic radiosurgery:

If you need sedation, have someone accompany you and drive you home afterward.

You should also tell your physician if any of the following apply to you:

- You are taking medications by mouth or insulin to control diabetes.
- You have a pacemaker, artificial heart valve, defibrillator, brain aneurysm clips, implanted pumps or chemotherapy ports, neurostimulators, eye or ear implants, stents, coils or filters.
- You suffer from claustrophobia.

What does the equipment look like?

Endovascular therapy:

These procedures, similar to surgery, are performed in specific rooms or suites, using specific tools and involving highly trained personnel. X-ray equipment, catheters and a variety of synthetic materials, medications, embolic agents, detachable coils and other devices may be used.

The equipment typically used consists of a fluoroscopic angiography suite with a procedure table, movable x-ray sources and detectors on opposite sides of the table, and television-like monitors for viewing images produced by the x-ray equipment. Monitors are located in the examining room and in a nearby control room with a structure allowing real-time viewing by the treating doctors suspended over the procedure table on which the patient lies. Typically, anesthetic equipment is present as well as physiologic monitoring equipment for use during the procedures, including an intravenous line (IV) and equipment that monitors heartbeat, blood pressure and oxygenation level.

Catheters are small tubes made of synthetic material and coated with a lubricating layer. They vary in size and length depending upon specific uses. Commonly, longer, smaller catheters are placed through larger, shorter catheters to allow navigation of the body's blood vessels.

Your physician will select an embolic agent depending on the type of disease being treated, size of the blood vessel, aneurysm or malformation and whether the treatment is intended to be permanent or temporary. These include:

- coils made of platinum that are used to block or occlude aneurysms or arteries. They can be positioned very precisely to occlude an aneurysm or stop bleeding from an injured artery.
- a new technology called flow diverter stents that treat specific types of brain aneurysms. These special stents redirect blood flow out of the aneurysm.
- liquid sclerosing agents such as alcohols, which are used to destroy blood vessels and vessel malformations. Filling a vessel or a vascular malformation with this liquid agent causes blood clots to form, closing up the abnormal vascular channels.
- liquid embolic agents. When injected into the target channel that needs to be closed off, these block blood flow by quickly hardening.
- Gelfoam™, a gelatin sponge material, which is cut into small pieces that are injected into an artery and float downstream until they can go no further. After a period ranging from a few days to two weeks, the material dissolves.
- particulate agents, including Polyvinyl alcohol (PVA) and gelatin-impregnated acrylic polymer spheres, which are suspended in liquid and injected into the bloodstream to block small vessels. These agents are used to block or occlude vessels permanently, including the treatment of uterine fibroid tumors.
- a balloon or stent used to unblock blood vessels to improve blood flow to the brain. In cases of acute stroke where a blood clot blocks a main artery in the brain, thrombectomy is performed with the use of stents or retrieval/aspiration systems.

Aneurysm coils are made of soft platinum wire smaller than a strand of hair that is wound into complex shapes. Various detachment mechanisms allow for precise, controlled placement by the treating physician. They are available in different diameters and lengths.

All detachable coils are scientifically proven to be safe and effective and approved by the U.S. Food and Drug Administration (FDA).

There are three types of embolic coils:

- bare platinum coils
- coated platinum coils
- biologically active coils

Stereotactic radiosurgery:

There are three basic kinds of stereotactic radiosurgery equipment, each of which uses different instruments and sources of radiation:

- The **Gamma Knife**®, which uses 192 or 201 beams of highly focused gamma rays all aiming at the target region. The Gamma Knife is ideal for treating small to medium size lesions. *See the Gamma Knife (https://www.radiologyinfo.org/en/info/gamma_knife) page for more information.*
- **Linear accelerator (LINAC)** machines, prevalent throughout the world, deliver high-energy x-rays, also known as photons. The linear accelerator can perform radiosurgery on larger tumors in a single session or during multiple sessions, which is called fractionated stereotactic radiotherapy. Multiple manufacturers make this type of machine, which have brand names such as Novalis Tx™, XKnife™, and CyberKnife®. *See the Linear Accelerator (https://www.radiologyinfo.org/en/info/linac) page for more information.*
- **Proton beam or heavy-charged-particle radiosurgery** is in limited use in North America, though the number of centers offering proton therapy has increased dramatically in the last several years. *See the Proton Therapy (https://www.radiologyinfo.org/en/info/protonthera) page for more information.*

How does the procedure work?

Endovascular therapy:

Embolization: Using x-ray imaging and a contrast material to visualize the blood vessel, the interventional neuroradiologist inserts a catheter through the skin into a blood vessel and advances it to the treatment site. A device or synthetic material called an embolic agent is then inserted through the catheter and positioned within the blood vessel, aneurysm or malformation where it will remain permanently, causing blockage of blood flow. In the case of brain aneurysms, commonly treated with devices called coils, the body responds by forming blood clots around the coil(s), which helps block the flow of blood into the bulge or passageway and keeps the aneurysm from rupturing or leaking. *See the Embolization of Brain Aneurysms and Arteriovenous Malformations/Fistulas page (https://www.radiologyinfo.org/en/info/dc-embol) for more information.*

Stroke Treatment: Using fluoroscopic x-ray imaging and contrast material to visualize blocked or narrow blood vessels, the interventional neuroradiologist inserts a catheter system through the skin into a blood vessel and advances it to the blockage. Devices such as stent retrievers/aspiration systems to open narrow blood vessels or remove clots can then be advanced through the catheter. Medications that dissolve clots or relax blood vessel spasms can also be injected.

Stereotactic radiosurgery:

Stereotactic radiosurgery is a highly precise form of radiation therapy used primarily to treat tumors and other abnormalities of the brain. Despite its name, stereotactic radiosurgery is a non-surgical procedure that delivers a single high-dose of precisely-targeted radiation using highly focused gamma-ray or x-ray beams that converge on the specific area or areas of the brain where the tumor or other abnormality resides, minimizing the amount of radiation to health brain tissue. When treated with radiosurgery, arteriovenous malformations (AVMs) begin to thicken and close off slowly, typically over several years.

How is the procedure performed?

Endovascular therapy:

Prior to your procedure, your doctor may perform ultrasound, computed tomography (CT), or magnetic resonance imaging (MRI) exams.

You will lie on the procedure table.

The doctor or nurse may connect you to monitors that track your heart rate, blood pressure, oxygen level, and pulse.

A nurse or technologist will insert an intravenous (IV) line into a vein in your hand or arm to administer a sedative. This procedure may use moderate sedation. It does not require a breathing tube. However, some patients may require general anesthesia.

Your doctor will numb the area with a local anesthetic. This may briefly burn or sting before the area becomes numb.

The nurse will sterilize the area of your body where the catheter is to be inserted. They will sterilize and cover this area with a surgical drape.

The doctor will make a very small skin incision at the site.

Catheter embolization: (https://www.radiologyinfo.org/en/info/cathembol) Using imaging guidance, a catheter (a long, thin, hollow plastic tube) is inserted through the skin into a blood vessel and maneuvered to the treatment site.

Contrast material is injected through the catheter and a series of x-rays are taken to locate the exact site of bleeding or abnormality. The medication or embolic agent is then injected through the catheter. Additional x-rays are taken to ensure proper treatment of the abnormality.

You can expect to stay in bed for six to eight hours after your procedure.

The length of the procedure varies from 30 minutes to several hours depending on the complexity of the condition.

Embolization of brain aneurysms and arteriovenous malformations (https://www.radiologyinfo.org/en/info/dc-embol) *:* Using image-guidance, a catheter, a long, thin, hollow plastic tube, is inserted through the skin into a blood vessel and maneuvered to the treatment site. A contrast material is then injected through the catheter and a series of x-rays are taken to locate the exact site of the abnormality.

The medication, embolic agent or device is then injected or advanced through the catheter. Additional x-rays are taken to ensure proper treatment of the abnormality.

When the procedure is complete, the doctor will remove the catheter and apply pressure to stop any bleeding. Sometimes, your doctor may use a closure device to seal the small hole in the artery. This will allow you to move around more quickly. No stitches are visible on the skin. The nurse will cover this tiny opening in the skin with a dressing.

Occasionally, a device or plug will be used to seal over or close the hole in the artery. This allows patients to return to their normal activities more quickly.

The doctor or nurse will remove your IV line before you go home.

The length of the procedure varies from 30 minutes to several hours depending on the complexity of the condition.

You can expect to stay in bed for six to eight hours after your procedure.

Stereotactic radiosurgery:

Gamma Knife radiosurgery involves four phases: placement of the head frame, imaging of the tumor location, computerized dose planning, and radiation delivery. In the first phase, a nurse will place a small needle in your hand or arm to give you medications and a contrast material, if needed, for imaging.

A neurosurgeon will use local anesthesia to numb two spots on your forehead and two spots on the back of your head. A box-shaped head frame will be attached to your skull using specially designed pins to keep your head from moving until the treatment session is finished. This lightweight aluminum head frame is also a guiding device that makes sure the Gamma Knife beams are focused exactly where the treatment is needed.

Next, you will be taken to an imaging area where a magnetic resonance imaging (MRI) scan will be performed to show the exact location of the tumor in relation to the head frame. In some cases, a computed tomography (CT) scan may be performed instead of, or in addition to, an MRI scan. If you are having treatment for an arteriovenous malformation, you may also have an angiogram.

During the next phase, you will be able to relax for an hour or two while your treatment team identifies the tumor(s) for treatment and develops a treatment plan using special computer software to specifically pinpoint and optimally irradiate the tumor and minimize dose to surrounding normal tissues.

Next, you will lie down on the Gamma Knife bed and your head frame will be fixed to the machine before beginning treatment. You will be made comfortable with a pillow or wedge-shaped sponge under your knees and a blanket over you. The treatment team will then go to the control room outside of the treatment room to begin your treatment. You will be able to talk to your physician through a microphone in the helmet and a camera will allow the team to see you at all times. The bed you are lying on will move backward into the Gamma Knife machine. You will not feel the treatment and the machine is very quiet.

Depending on the Gamma Knife model and the treatment plan, the whole treatment may be performed without interruption or it may be broken up into multiple smaller parts. The total treatment may last less than one hour or up to four hours. A chime will sound when the treatment is complete and the bed will return to its original position. As soon as the treatment is finished, you will sit up and the head frame will be removed. In most cases, you should be able to go home soon afterward.

Linear accelerator (LINAC) radiosurgery is similar to the Gamma Knife procedure and its four phases: head frame placement, imaging, computerized dose planning and radiation delivery. Unlike the Gamma Knife, which remains motionless during the procedure, part of the LINAC machine called a gantryrotates around the patient, delivering radiation beams from different angles. Compared to the Gamma Knife, the LINAC uses a larger x-ray beam, which enables larger tumors to be treated more uniformly. It can be used for fractionated radiosurgery or stereotactic radiotherapy using a relocatable frame, which is an advantage for large tumors or particularly critical locations.

For CyberKnife radiosurgery, a head frame is not necessary. Instead, a plastic mesh mask will be made to help hold your head in position and a detailed CT scan will be performed with your mask on. You may also have an MRI scan to align with this CT scan in the treatment planning computer. The imaging, treatment planning, and first treatment may be spread out over multiple days. You may have up to five treatments over the span of one or one and a half weeks.

For the treatment, you will lie down and the mask will be placed over your head. X-ray images will be taken to ensure that you are in proper position, and then the treatment will begin. Your radiation therapist will monitor you at all times from outside the treatment room. The robotic arm will move around you to aim at the target from a hundred or several hundred directions. Your head won't have to remain perfectly still during treatment; x-ray images taken every minute or so will detect any small movements of your head and the robot will correct for these small movements to ensure accuracy throughout the treatment. The treatment may last about one or two hours.

What will I experience during and after the procedure?

Endovascular therapy:

The doctor or nurse will attach devices to your body to monitor your heart rate and blood pressure.

You will feel a slight pinch when the nurse inserts the needle into your vein for the IV line and when they inject the local anesthetic. Most of the sensation is at the skin incision site. The doctor will numb this area using local anesthetic. You may feel pressure when the doctor inserts the catheter into the vein or artery. However, you will not feel serious discomfort.

If you receive a general anesthetic, you will be unconscious for the entire procedure. An anesthesiologist will monitor your condition..

If the procedure uses sedation, you will feel relaxed, sleepy, and comfortable. You may or may not remain awake, depending on how deeply you are sedated.

You may feel slight pressure when the doctor inserts the catheter, but no serious discomfort.

As the contrast material passes through your body, you may feel warm. This will quickly pass.

Stereotactic radiosurgery:

Radiosurgery treatments are similar to having an x-ray. You will not be able to see, feel or hear the x-rays. There is no pain or discomfort from the actual treatment. If you experience pain for other reasons, such as back pain or discomfort from the head frame, you should let your doctor or nurse know.

When the head frame is removed, there may be some minor bleeding from the pin sites that will be bandaged. You may experience a headache and can ask for medication to help make you feel more comfortable. In most cases, patients can resume all of their normal activities within one or two days.

Who interprets the results and how do I get them?

After the procedure is complete, the interventional radiologist will tell you whether the procedure was a success.

Your interventional radiologist may recommend a follow-up visit.

This visit may include a physical check-up, imaging exam(s), and blood tests. During your follow-up visit, tell your doctor if you have noticed any side effects or changes.

What are the benefits vs. risks?

Benefits

- No surgical incision is necessary—only a small nick in the skin that does not need stitches.

Catheter embolization:

- Embolization is a highly effective way of controlling bleeding, especially in an emergency situation.
- Embolization is much less invasive than conventional open surgery. As a result, there are fewer complications and the hospital stay is relatively brief—often only the night after the procedure. Blood loss is less than with traditional surgical treatment, and there is no obvious surgical incision.

- This method can be used to treat tumors and vascular malformations that either cannot be removed surgically or would involve great risk if surgery was attempted.

Embolization for brain aneurysms and arteriovenous malformations:

- Using detachable coils to close off an aneurysm, or a liquid embolic agent in the case of an arteriovenous malformation, is highly effective in preventing bleeding.
- Embolization is a treatment for cerebral aneurysms and fistulas that previously were considered inoperable. This procedure is less invasive and requires significantly less recovery time than open surgery for aneurysm repair. An additional benefit is minimal blood loss. Compared to open surgery, endovascular treatment of cerebral aneurysms has lower risks of severe complications, stroke or death.

Acute ischemic stroke treatment:

- In cases of an acute ischemic, endovascular therapy (a minimally invasive procedure to improve blood flow in the brain's arteries) is performed. Depending on the severity of the symptoms, devices such as stent retrievers/aspiration systems are used to open blocked blood vessels or remove clots. Medications that dissolve clots or relax blood vessel spasms can also be injected. This restores blood flow to the affected area of the brain, increasing the chance for recovery.

Risks

- There is a very slight risk of an allergic reaction if the procedure uses an injection of contrast material.
- Any procedure that places a catheter inside a blood vessel carries certain risks. These risks include damage to the blood vessel, bruising or bleeding at the puncture site, and infection. The doctor will take precautions to mitigate these risks.

Embolization procedures:

- There is always a chance that an embolic agent can lodge in the wrong place and deprive normal tissue of its oxygen supply.
- There is a very small risk of death or significant illness including stroke. In the treatment of cerebral aneurysms, this risk is smaller compared to open surgery. Coil embolization of unruptured aneurysms and fistulas carries less risk than embolization of aneurysms with prior bleeding. Approximately 10 percent of cases require additional treatment or surgery.

Disclaimer

Copyright