Vascular Access Procedures

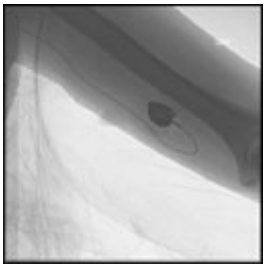
What are Vascular Access Procedures?

A vascular access procedure involves the insertion of a flexible thin plastic tube, or catheter, into a blood vessel to provide an effective method of drawing blood or delivering medications and nutrients into a patient's bloodstream over a period of weeks, months or even years.

A simple intravenous (IV) line is effective for short-term use, but is not suitable for long-term use. When an IV line is necessary for a longer period of time and/or a more secure venous access is necessary, a special catheter that is generally longer, called a central access catheter, or a similar device can be used. The catheter can remain in place either temporarily (days) or long-term (weeks to years) so that it can be easily and repeatedly accessed over the necessary period of time without the need for repeat punctures to the patient.

In a vascular access procedure, a special catheter is inserted inside a major vein (generally in one of the large veins in the neck, arms or legs) with the tip of catheter positioned into a large central vein that terminates near the heart.

What are some common uses of the procedure?



Vascular access procedures are performed when patients need:

- intravenous antibiotic treatment.
- chemotherapy, or anti-cancer drugs.
- long-term intravenous (IV) feeding for nutritional support.
- repeated drawing of blood samples.
- hemodialysis, a process used to treat patients whose kidneys are not working properly. It involves a special machine and tubing that removes blood from the body, cleanses it of waste and extra fluid and then returns it back to the body.

Access catheters may also be used for:

- blood transfusions.
- patients who have difficulty receiving a simple IV line.

Vascular access procedures are commonly performed in children for similar reasons with similar techniques using appropriately sized devices intended for children. Examples of reasons for vascular access procedures in children include:

- intravenous antibiotic treatment.
- chemotherapy.
- delivering special heart medications.
- long term intravenous (IV) feeding for nutritional support.
- hemodialysis.
- blood transfusions.
- patients who have difficulty receiving a simple IV line.
- repeated drawing of blood samples.

How should I prepare?

Prior to your procedure, your blood may be tested to determine how well your kidneys are functioning and whether your blood clots normally.

You should report to your doctor all medications that you are taking, including herbal supplements, and if you have any allergies, especially to local anesthetic medications, general anesthesia or to contrast materials containing iodine (sometimes referred to as "dye" or "x-ray dye"). Your physician may advise you to stop taking aspirin, nonsteroidal anti-inflammatory drugs (NSAIDs) or blood thinners for a specified period of time before your procedure.

Women should always inform their physician and x-ray technologist if there is any possibility that they are pregnant. Many imaging tests are not performed during pregnancy so as not to expose the fetus to radiation. If an x-ray is necessary, precautions will be taken to minimize radiation exposure to the baby. See the Safety page (www.RadiologyInfo.org/en/safety/) for more information about pregnancy and x-rays.

You will receive specific instructions on how to prepare, including any changes that need to be made to your regular medication schedule.

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

You should plan to have a relative or friend drive you home after your procedure.

You may be asked to remove some or all of your clothes and to wear a gown during the exam. You may also be asked to remove jewelry, removable dental appliances, eye glasses and any metal objects or clothing that might interfere with the x-ray images.

What does the equipment look like?

In this procedure, x-ray and ultrasound equipment, a needle, a guide wire and a vascular access catheter are used.

The equipment typically used for this examination consists of a radiographic table, an x-ray tube and a television-like monitor that is located in the examining room. Fluoroscopy, which converts x-rays into video images, is used to watch and guide progress of the procedure. The video is produced by the x-ray

machine and a detector that is suspended over a table on which the patient lies.

The x-ray equipment allows the operator to watch the wire and catheter on a live display so they can be advanced safely and the catheter tip positioned accurately to allow the catheter to function best.

Ultrasound scanners consist of a console containing a computer and electronics, a video display screen and a transducer that is used to scan the body.

Ultrasound is used to assess and identify a vein that is suitable for catheter placement. It also allows the interventional radiologist the ability to identify appropriate veins that may be larger and deeper than veins that can be seen or felt on the skin surface. Ultrasound gel is used to improve the contact of the transducer to the skin in order to improve image quality. Ultrasound guidance is helpful because it provides real-time or live visualization for the interventional radiologist to advance the needle directly into the vein during the venous puncture (or access) process. This helps improve the likelihood of a successful venous puncture and also helps the interventional radiologist avoid surrounding structures reducing the risk for possible complications such as bleeding.

In contrast to the catheter used in a standard intravenous (IV) line, a vascular access catheter is more durable and does not easily become blocked or infected. These catheters are designed in a way that they extend into the largest central vein near the heart.

A catheter is a long, thin plastic tube that is the same size or smaller than a pencil.

Following are the major types of vascular access catheters:

- A peripherally inserted central catheter (PICC) is a long catheter that extends from an arm or leg vein into the largest vein (superior vena cava or inferior vena cava) near the heart and typically provides central IV access for several weeks, but may remain in place for several months. These catheters are called "midline catheters" when they are placed in a way that the tip of the catheter remains in a relatively large vein, but doesn't extend into the largest central vein. They may have one or two lumens and some may be able to be used for CT contrast injections (manufactured for forceful contrast injections).
- A non-tunneled central catheter may be larger caliber than a PICC, and is designed to be placed via a relatively large, more central vein such as the jugular vein in the neck or the femoral vein in the groin. The skin exit point of a non-tunneled central catheter is in close proximity to the entry point of the vein used.
- A tunneled catheter may have a cuff that stimulates tissue growth that will help hold it in place in the body. Examples of the tunneled catheter include HICKMAN® catheters, BROVIAC® catheters and GROSHONG® catheters. There are several different types of dialysis catheters. The tunneled catheter is the best choice when access to the vein is needed for long period of time. It is secure and easy to access. They are more secure and usually work more efficiently than PICCs because of their larger size. The tunnel and cuff on the catheter decrease the risk of catheter infection, allowing these types to remain in place for extended periods of time. This type of catheter has portions that hang outside the skin, and is used by connecting directly to the out side ports of the catheter. The patient's skin is not directly punctured when the catheter is used. This type of catheter must be protected from getting pulled or getting wet. The skin exit point of a tunneled catheter is remote from the actual vein entry point. This tunneled path also helps reduce the risk of infection.
- A port catheter, or subcutaneous implantable port, is a permanent device that consists of a catheter attached to a small reservoir, both of which are placed under the skin similar to tunneled catheters. This catheter is placed completely under the skin. The patient's skin is punctured every time the catheter is used, but there are no restrictions on showering or bathing once the incision

made for placement heals.

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Other equipment that may be used during the procedure includes an intravenous line (IV) and equipment that monitors your heart beat and blood pressure.

How is the procedure performed?

A midline catheter and some peripherally inserted central catheter (PICC) lines may be inserted at your bedside without image guidance. These are inserted through a vein near the elbow and threaded through a large vein in the upper arm.

Other vascular access procedures are most often performed by a specially trained interventional radiologist in an interventional radiology suite or occasionally in the operating room.

These procedures are often performed on an outpatient basis.

You will be positioned on your back.

A nurse or technologist may insert an intravenous (IV) line into a vein in your hand or arm so that sedative medication can be given intravenously. PICC placement usually does not require sedative medications.

The area of your body where the catheter is to be inserted will be shaved (typically the upper chest for tunneled catheters and in the arm for PICCs), sterilized and covered with a surgical drape.

Your physician will numb the area with a local anesthetic.

A very small nick is made in the skin at the site.

PICC: To place a PICC line, the physician or nurse will identify the vein using ultrasound or x-ray guidance and insert a small needle into the arm vein and advance a small guide wire into the large central vein, called the superior vena cava, under x-ray (fluoroscopy). The catheter is then advanced over the guide wire and moved into position. The guide wire is then removed. If this is done without x-ray guidance, a chest x-ray is needed to confirm the catheter position.

NON-TUNNELED CENTRAL CATHETER: These catheters are placed via a relatively larger vein such as the jugular vein in the neck or femoral vein in the groin.

TUNNELED CATHETER: For a tunneled catheter, the physician will make one small incision in the skin commonly in the lower neck. Using ultrasound guidance, the vein is punctured with a needle (usually the jugular vein at the base of the neck), and a small guide wire is advanced into the large central vein, called the superior vena cava, under x-ray guidance (fluoroscopy). A second small skin incision may be made below the first, and a tunnel under the skin is then created. Using x-ray guidance, the catheter is placed through the tunnel into the vein, and the tip of the catheter is placed into the largest vein, the superior vena cava. The cuff, which is typically made of Dacron®, is located under the skin in the tunneled path of the catheter. Finally, the physician will place stitches at end of the tunnel to help keep the catheter firmly in place. The stitches do not typically need to be removed until the catheter is taken out.

PORT-CATHETER: Implanting a subcutaneous port generally requires two incisions (except in the arm where a single incision may suffice). The port reservoir is placed under the skin. A small skin incision slightly longer than the diameter of the device itself is made, and a small pocket for the port is created under the skin. The rest of the procedure is similar to the tunneled central catheter placement. A small, elevated area remains on your body at the site of the reservoir at the conclusion of the procedure. The port, which passes from an access site in a vein of your arm, shoulder or neck, ends in a large central vein in the chest. The reservoir has a silicone covering that can be punctured with a special needle.

Incisions are held together by stitches, surgical glue and/or a special tape.

An x-ray may be performed after the procedure to ensure the catheter is positioned correctly but is frequently not necessary if x-ray (fluoroscopy) was used during the placement procedure.

The implanted vascular access catheter is then ready for use.

Your intravenous line will be removed.

For pediatric patients, a smaller catheter or other equipment may be used. X-ray equipment settings will be adjusted to lower the radiation dose used to guide the placement of the catheter.

Pediatric procedures are more commonly performed with deeper sedation, possibly with the assistance of an anesthesiologist. Your child may be required to have nothing to eat or drink for up to six hours before the procedure. You will be given detailed instructions depending on the age of your child.

Let your physician know about any medication, x-ray dye or latex allergies your child may have, as well as previous responses to sedation. If your child has had previous vascular access devices, previous surgery in the same area, or has unusual anatomy, let your physician know so they can plan the best location for the device. If a PICC line is to be placed in the arm, your child may have a preference for which arm is used. You can discuss this with the physician in advance.

What will I experience during the procedure?

Devices to monitor your heart rate and blood pressure will be attached to your body.

You will feel a slight pin prick when the needle is inserted into your vein for the intravenous line (IV) and when the local anesthetic is injected.

If the case is done with sedation, the intravenous (IV) sedative will make you feel relaxed and sleepy. You may or may not remain awake, depending on how deeply you are sedated.

You may feel some pressure or brief discomfort when the needle is placed into the vein and when the tunnel is created. If the arm is used for a PICC line placement, a tourniquet will be positioned on the upper arm. A tourniquet may be used to help dilate the vein and aid with the initial venous puncture.

You will have to lay flat for about 30 to 45 minutes during catheter placement.

If you are not staying overnight at the hospital, you should rest at home for the remainder of the day following the procedure. You may resume your usual activities the next day, but should avoid lifting heavy objects.

After having a tunneled catheter or subcutaneous port placed, you may experience bruising, swelling

and tenderness in the chest, neck or shoulder, but these symptoms clear up in a few days. Pain medicine may help during this time.

You will receive instructions on how to care for your incision(s) and your particular vascular access device. For the first week, it is especially important to keep the catheter site clean and dry. Some, but not all, physicians will recommend sponge bathing around the catheter site, then cleaning the area with peroxide, applying an ointment that contains an antibiotic and bandaging the area.

You may be allowed to shower after one week, using a piece of plastic wrap over the site where the catheter was inserted. You should not allow the incision to be held under water such as by swimming or soaking in a tub.

You may be advised to flush your catheter with a heparin solution to help keep blood clots from forming and blocking the catheter.

You should call the physician or nurse if you have any questions about your vascular access device or if:

- the device malfunctions.
- there is bleeding at the insertion site.
- you develop a fever.
- you notice redness, increased swelling, tenderness, warmth or fluid drainage at the catheter insertion site.

Vascular access catheters are usually removed by a health professional. PICC and non-tunneled central catheters may be removed by nurses or technologists similar to the way an IV would be removed, and the site covered with a Band-Aid. Tunneled catheters and port catheters will be removed by a physician. To remove these catheters, the skin is numbed with local anesthesia. An incision is required to remove the port catheter. Removal takes about 15 minutes and is done as an out-patient procedure. The skin will need to be protected from water until the incision is fully healed after removal.

Who interprets the results and how do I get them?

Your interventional radiologist will use x-ray imaging during the placement procedure or a chest x-ray taken immediately after the procedure to confirm that your catheter is correctly positioned. Your physician will also check how well your vascular access device is functioning by using a needle and/or syringe and injecting fluid through the catheter.

What are the benefits vs. risks?

Benefits

- A central catheter permits infusion of solutions containing medication or nutritional substances without causing the complications that may occur with an IV, such as local tissue damage when a toxic drug leaks out of the vein.
- In many conditions, having this type of tube inserted provides a simple and painless means of drawing blood, or delivering drugs, nutrients or both.
- Vascular access devices spare the patient the discomfort and stress of repeated needle sticks.

- The vascular access device is an extremely useful solution for patients who—for any reason—require repeated entry into the venous circulation over a long period. A number of different designs are available that are suitable for different circumstances.
- Placement of a vascular access device is a great solution for those requiring prolonged treatment such as chemotherapy. They will not need to have an IV line placed for each treatment and their arm veins will not become badly scarred.
- A PICC is very helpful when medicines or fluids that are irritating to the wall of the vein are needed. A wide range of products may be given by this route, including antibiotics and blood products. The catheter also may be used for IV feeding and frequent blood sampling.
- A vascular access device may be used immediately after placement. Some types will continue functioning well for a year or longer. The devices are easily removed when no longer needed.
- A catheter sometimes is the only way of getting access to the circulatory system for hemodialysis in patients with serious kidney disease.

Risks

Two types of risk are associated with vascular access devices: those occurring during or shortly after placement and delayed risks that occur simply because the device is in your body.

Following are some of the risks associated with placement of a vascular access device:

- Any procedure that involves placement of 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.
- An infection may develop at an incision site shortly after catheter placement. The risk is less if you carefully follow instructions about caring for the incisions as they heal.
- Bleeding or hemorrhaging may occur. This risk can be minimized through a blood test in advance to be sure that your blood clots normally. If your blood is too thin, the procedure may be postponed or you may receive medication or blood products to improve blood clotting.
- Very rarely a patient may develop a condition called a pneumothorax, a collection of air in the chest that may cause one of the lungs to collapse. This may occur during placement of a catheter or port using a vein in the chest or neck, but not when an arm vein is used. The risk is lessened when catheter placement is guided by ultrasound or fluoroscopy. Placement of these catheters by interventional radiologists using appropriate imaging guidance significantly decreases the risk of pneumothorax.
- The normal heart rhythm may be disturbed while the catheter is inserted, but this is usually only temporary. The problem is easily recognized during the procedure and eliminated by adjusting the catheter position.
- Rarely, the catheter will enter an artery rather than a vein. If this happens, the catheter will have to be removed. Most often the artery then heals by itself, but occasionally it has to be surgically repaired.

Delayed Risks:

- Two types of delayed infection may develop: skin infection at the catheter or port insertion site or bloodstream infection. Infections are least common after placing a port. The risk of delayed infection can be minimized if you and anyone else who will be handling the device wash hands before flushing it or cleaning the insertion site. The site should be carefully inspected each time the dressing is changed. The risk of infection is higher for individuals who have low white blood cell counts.

- A hole or break in the catheter may lead to leakage of fluid. Breaks may be avoided by not always clamping the catheter in the same spot and by never using too much force when flushing it. Two important first aid measures: 1) clamp the catheter between the damaged part and the skin insertion site; 2) tape a sterile gauze pad to the skin to cover the break. Catheters rarely fracture inside the body, but if this does happen, a chest x-ray will show the problem. The broken fragment can usually be removed without open surgery.
- The catheter may become accidentally dislodged. If the catheter is not secured to the skin appropriately, it may come out. If this happens, you should apply pressure to the incision site using a sterile dressing and call your physician immediately.
- A large amount of air in the catheter may create an emergency that causes chest pain or shortness of breath. If you develop chest pain or shortness of breath related to air being pushed into the vein through the catheter, you should clamp the catheter right away, lie on your left side and call 9-1-1. This problem can be avoided by always clamping the catheter before and after inserting a syringe, and by making sure that the catheter cap is screwed on tightly.
- Any type of vascular access catheter may become obstructed by clotted blood or fibrin sheath. You can minimize the risk by carefully following instructions about flushing the catheter. Once a catheter occludes, or becomes closed off, it sometimes can be cleared by injecting medication but at other times must be removed or exchanged for a new catheter. Occasionally the catheter can be stripped by a simple interventional procedure.
- If the vein in which the catheter lies becomes occluded (closed off) the arm, shoulder, neck or head may develop swelling. If this occurs, call your physician immediately. The clot may be treated by a blood-thinning medication, but occasionally the catheter will have to be removed.
- Rarely, patients experience a sensation of skipped or irregular heartbeat that may be related to the catheter. Call your physician if this occurs. The catheter tip may need to be readjusted slightly to relieve this.

What are the limitations of Vascular Access Procedures?

Although some types of central venous catheter may remain in place for months or even years, most catheters require replacement after certain time frame because of poor function. The reservoir septum of most types of implanted ports has a useful lifetime of about 1,000 punctures and so is not suitable for patients who require IV access on a daily basis.

Some patients have very poor veins that are not well suited for catheter placement. This usually happens when these access veins have been used for a long period of time (years of intravenous feeding, etc.). It may be very difficult to find a suitable vein to place a catheter in these patients, and may require unusual venous entry sites (e.g., through the back or through the liver).

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