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Testing in the Noninvasive Vascular Laboratory

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The circulatory system is made up of the heart and blood vessels. The heart is the pumping organ that circulates blood through the vessels. There are 3 major types of blood vessels: arteries, which carry oxygen-rich blood to the organs and limbs; veins, which return blood from the organs and the limbs to the heart to be resupplied with oxygen by the lungs; and the lymphatics, which return fluid from the skin and tissues to the veins.

Why Has My Doctor Sent Me to the Vascular Laboratory?

Disorders of the blood vessels are common, and there are many different vascular disorders (Table 1). After a doctor's physical examination, testing in the vascular laboratory is often the first step in diagnosing vascular disease.

The most common disorder of the arteries is atherosclerosis, or clogging of the arteries with cholesterol-rich plaque, and it can occur in almost any artery of the body. The symptoms of atherosclerosis depend on the location of the blocked arteries. Aneurysm, or severe enlargement of a blood vessel, is another common disorder of arteries.

The most common location for an aneurysm is the abdominal portion of the aorta. This abnormality is known as abdominal aortic aneurysm. The aorta is the largest artery that delivers blood from the heart to the rest of the body through its branches.

There are also many disorders of the veins. Deep vein thrombosis is a serious disorder that usually requires immediate treatment. Deep vein thrombosis most frequently occurs in the veins of the legs, but it also can develop in the veins of the arms or the abdomen. Varicose veins are bulging veins that appear on the legs, may be unsightly, and may cause discomfort. Venous insufficiency is the term used to describe damaged veins that allow backward flow of blood down the legs, causing leg swelling, color changes of the skin, or ulcers (sores).

Lymphedema is severe swelling of the arm or the leg caused by loss of normal lymphatic vessels. Lymphatics may be lost or damaged, for example, as a result of prior treatment for breast or prostate cancer, as a result of infection, or as an inherited disorder. There is no specific test in the vascular laboratory to diagnose lymphedema, and the diagnosis of lymphedema usually

is made on the basis of a doctor's examination.

What Tests Are Done in the Vascular Laboratory?

Ultrasound is the most important tool in the vascular laboratory. A special probe that creates ultrasound waves is placed against the skin. Ultrasound waves then travel through the skin, muscle, and blood vessels. Some of the sound waves bounce off the structures in their path and return to the ultrasound machine, thereby delivering important information that is used to make pictures of the tissues on the monitor in black, white, and shades of gray. Sound waves that return from the body also carry important information about the blood flow in the arteries and veins. This is known as Doppler ultrasound, which is used to determine the direction and speed of blood flow and whether there is a blockage within a blood vessel. As your ultrasound study is being done, you will likely recognize the distinctive sounds of the Doppler. The Doppler sounds coming from an artery sound like a whip, whereas the sounds coming from a vein sound like the blowing wind.

The information contained in this *Circulation* Cardiology Patient Page is not a substitute for medical advice, and the American Heart Association recommends consultation with your doctor or healthcare professional.

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TABLE 1. Common Disorders of Blood Vessels

Arteries
Atherosclerosis
Carotid artery disease
Peripheral arterial disease
Renal artery stenosis (clogged kidney arteries)
Mesenteric artery disease (clogged arteries to the intestines)
Aneurysm (such as abdominal aortic aneurysm)
Raynaud's phenomenon (spasm of the small arteries of the hands and feet)
Trauma to the artery
Inherited abnormalities
Veins
Deep venous thrombosis (blood clot)
Superficial venous thrombosis (phlebitis)
Varicose veins
Venous insufficiency
Inherited abnormalities
Lymphatic vessels
Lymphedema

Larger ultrasound machines are used to take pictures of blood vessels and to assess blood flow in these vessels with Doppler (Figure 1). Some of the newest portable ultrasound machines can be as small as a laptop computer. The smallest ultrasound ma-



Figure 1. Carotid ultrasound examination. The ultrasound probe is placed against the neck by the sonographer, and an image of the blood vessel is generated on the ultrasound screen. The sonographer will carefully study the blood vessels on both sides of the neck to look for narrowing of the carotid arteries caused by atherosclerosis.



Figure 2. Segmental leg pressure measurements with pulse-volume recordings. Multiple blood pressure cuffs are placed on each leg. The sonographer will inflate the cuffs in sequence to measure the blood pressure and blood flow at each level and to determine the location of blockages. This test also can be performed on the arms.

chines can fit into a doctor's laboratory coat pocket. These hand-held Doppler machines are made only for listening to blood flow, not for imaging vessels. A hand-held Doppler device is used to measure blood pressures in the arms and the legs to determine the ankle-brachial index, which is the most important test used to diagnose atherosclerosis of the legs or peripheral arterial disease. In some cases, the ankle-brachial index is measured with the patient at rest and then repeated after the patient walks on a treadmill for a short period of time. This exer-

cise ankle-brachial index test may help to diagnose peripheral arterial disease in borderline cases or when the resting ankle-brachial index is normal, and it may be helpful to determine whether a patient's leg symptoms are due to peripheral arterial disease.

Segmental pressures and pulse-volume recordings are other important tools used in the vascular laboratory (Figure 2). A series of blood pressure cuffs are placed at multiple levels on the arms or the legs to measure pressures and the amount of blood flow at each level. These tests are performed to localize the area of blockages in the arm or the leg.

In general, the specific test that you will have done during your visit to the vascular laboratory will depend on your symptoms and the suspected vascular problem (see Table 2).

What Should I Expect During My Visit?

Vascular testing is performed by a health-care professional known as a vascular technologist or a sonographer. Depending on the specific test ordered, you may be asked to change into a hospital gown. You will be asked to either lie down or sit down on an examination table. The sonographer may ask questions about your symptoms and your medical history. If you are having an ultrasound test done, the sonographer

TABLE 2. Possible Tests for Suspected Vascular Disease

Symptom	Possible Test
Swollen and painful leg	Ultrasound of the veins to rule out a blood clot
Stroke or ministroke (transient ischemic attack)	Ultrasound of the carotid arteries
Leg pain during walking	Ankle-brachial index before and after walking on a treadmill
Nonhealing sore of the foot	Segmental leg pressure measurements and pulse-volume recordings
Follow-up of a leg artery stent	Ankle-brachial index and ultrasound of the leg artery
Pulsating mass in the abdomen detected by a doctor	Ultrasound of the aorta
Poorly controlled high blood pressure	Ultrasound of the renal (kidney) arteries
Varicose veins and leg swelling	Ultrasound of the veins with maneuvers to test for backflow of the veins
Pain and color changes of the fingers (suspected Raynaud's)	Segmental arm pressure measurements and pulse volume recordings

will apply a small amount of gel to the skin before placing the probe on the skin surface. The sonographer will take a specific number of images, depending on the study being performed. The study can be as short as 15 minutes or as long as 1 hour. If you are having a pulse-volume recording study, the sonographer will wrap a series of blood pressure cuffs around your legs or arms. The sonographer will inflate the blood pressure cuffs at different levels in the arm and leg to obtain segmental blood pressures and waveforms with a hand-held Doppler device and the pulse-volume recording machine.

Once the study is complete, the images are sent to a physician with expertise in vascular testing for review and interpretation. A report is then sent to the physician who has requested the study, and your physician will explain the findings to you.

I Just Had a Test in the Vascular Laboratory Last Year; Why Did My Doctor Request the Same Test Again?

Testing in the vascular laboratory is used not only to diagnose vascular problems but also to follow up for progression of these disorders. Vascular testing can be used to monitor a disorder over time and can help to determine whether additional treatment is necessary. For example, a pa-

tient with an aneurysm of the abdominal aorta may return to the vascular laboratory on a yearly basis to monitor the size of the aneurysm and to determine when repair is necessary. Patients who have undergone a vascular procedure such as a leg artery stent or a carotid endarterectomy may have a vascular test at regular intervals to ensure that there is no renarrowing of the vessels.

How Should I Prepare for the Test?

In general, little preparation is required for a noninvasive vascular test. Wear comfortable clothing to the laboratory and comfortable shoes if your physician has ordered an exercise ankle-brachial index test. If you are having an ultrasound study of the blood vessels in the abdomen, you should not eat or drink anything after midnight before your test. If you will be fasting for an abdominal ultrasound study, ask your physician if you should take your medications on the morning of the test.

Are There Any Risks Associated With Testing in the Vascular Laboratory?

Testing in the vascular laboratory is safe and noninvasive. There are no side effects of vascular ultrasound when performed in a qualified center.

You may feel minimal discomfort during the vascular study, such as during inflation of the blood pressure cuffs or with the pressure of the ultrasound probe against the skin.

Where Should I Have My Vascular Test Performed?

The Intersocietal Commission for the Accreditation of Vascular Laboratories certifies noninvasive vascular laboratories throughout the United States with a series of quality standards. The American College of Radiology also accredits quality ultrasound facilities, including those that perform vascular testing. Ask your physician or the vascular laboratory staff if theirs is an accredited facility.

Disclosure

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Additional Resources

Intersocietal Commission for the Accreditation of Vascular Laboratories. Patient information page. Available at: <http://www.icavl.org/icavl/news/patientinfo.htm>. Accessed March 22, 2007.

Society for Vascular Ultrasound. Patient checklist: "Should I have this ultrasound test?" Available at: <http://www.svunet.org/about/positions/position.screening.htm>. Accessed March 22, 2007.

Vascular Disease Foundation. Information for patients on many aspects of vascular disease. Available at: <http://www.vdf.org>. Accessed March 22, 2007.