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## Peripheral Arterial Disease

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**T**he circulatory system is a network of specialized tubes (known as blood vessels) that carry oxygen- and nutrient-rich blood to the organs and tissues of the body. There are 3 types of blood vessels: arteries, veins, and lymphatics. The heart is the pumping organ of the body. It pumps oxygen- and nutrient-rich blood into the aorta, which is the main artery of the body. The branches of the aorta, known as the arteries, carry blood to the organs of the body, such as the kidneys, the liver, and the intestines, as well as to the arms and legs (extremities). The veins return blood from the organs and the extremities to the heart to replenish the blood with oxygen and restart the process. This cycle repeats thousands of times each day. The lymphatics are the third type of blood vessels of the circulation. Lymphatics collect fluid from the tissues of the body and filter it through the lymph nodes. The lymphatics eventually connect with veins to return fluid from the tissues to the blood and the heart. This article focuses on a disorder of the arteries known as peripheral arterial disease (PAD).

### PAD Is Atherosclerosis of the Extremities

PAD is a medical condition caused by blockages of the arteries that provide blood flow to the arms or legs. You may have also heard of this problem referred to as peripheral vascular disease (PVD) or “bad circulation.” In PAD, the arteries become blocked by cholesterol plaque caused by atherosclerosis. Atherosclerosis is a common problem in Western societies. Atherosclerosis can involve almost all of the major arteries of the body. Atherosclerosis of the arteries of the heart is known as coronary artery disease, the process that causes chest pain (angina) and heart attack (myocardial infarction). Atherosclerosis of the arteries of the neck and brain, known as cerebrovascular disease, causes strokes. Atherosclerosis of the arteries of the arms and legs, as well as the aorta, is known as PAD. Many frequently occurring conditions place people at risk for developing PAD. The conditions that increase the risk of PAD are the same risk factors that increase the risk of heart attack or stroke (see the box titled “Common Risk Factors for PAD”). Cigarette smoking, both to-

bacco and marijuana, is the most important correctable risk factor for the development of PAD, whereas age is the most significant nonreversible risk factor. Researchers are actively working to figure out why PAD specifically and atherosclerosis in general develop in some people but not in others. Some of the newer areas of interest include chronic inflammation of blood vessels and inherited (genetic) factors.

### Common Risk Factors for PAD

- Smoking
- Diabetes
- High blood pressure
- High cholesterol
- Advanced age (greater than 70 years)

### Symptoms of PAD

The most common complaint that is caused by PAD is leg pain brought on by walking (see the box titled “Symptoms of PAD”). This leg pain is also known as intermittent claudication.

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

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Claudication is a sensation of aching, burning, heaviness, or tightness in the muscles of the legs that usually begins after walking a certain distance, walking up a hill, or climbing stairs, and goes away after resting for a few minutes. The ache can be felt in the buttocks, thighs, or calves. In some patients, particularly patients more than 70 years old, the feeling of claudication may be different from this classic or textbook description (such patients are said to have atypical symptoms). Your doctor must distinguish leg pain due to claudication from other causes of leg pain, such as painful joints (arthritis), tingling or a “pins-and-needles” sensation (neuropathy), and pain running down the back of the thighs due to arthritis of the spine (sciatica or spinal stenosis). Your doctor will be able to distinguish claudication from other types of leg pain on the basis of your description of the symptoms and a thorough physical examination. Sometimes it is difficult to determine the specific cause of the leg discomfort, or you may have more than one problem, so your doctor may order additional tests, which are discussed below. Patients with severe PAD may have claudication after walking a short distance or may have pain in the legs or feet when at rest or when lying in bed at night. In severe cases, patients may develop a sore (ulcer) that will not heal on its own or



**Figure 1.** For the ABI test, a nurse measures the blood pressure in the ankle of a patient using a handheld ultrasound device. The ABI is determined in each leg, and the results are used by a doctor to diagnose PAD.

blackened skin (gangrene) on the foot or toe.

Some patients can have PAD and claudication of the arms, although this is much less frequent than PAD of the legs. These patients may experience arm discomfort while performing routine housework or brushing their teeth or hair. The diagnosis of PAD of the arms can generally be made by a doctor’s examination. Patients with PAD of the arms often have a large difference in the blood pressure readings between the right and left arms.

PAD can also cause unusual symptoms. In some men, the only symptom of PAD may be the inability to have or maintain an erection (erectile dysfunction). Finally, in many cases, patients who have significant blockages in the arteries supplying blood to the legs have no symptoms at all and can only be diagnosed by a doctor’s examination and a test known as the ankle-brachial index (ABI), which is discussed below. We are becoming aware of the fact that for each patient with PAD and claudication, there may be another patient with PAD who has no symptoms.

### How PAD Is Diagnosed

In most cases, your doctor can diagnose PAD on the basis of a careful medical history and a thorough physical examination. The physical examination focuses on your heart and blood vessels. Because atherosclerosis oc-

curs throughout the entire body, patients with PAD are at high risk for atherosclerosis in the other arteries of the body. Your doctor measures your blood pressure and carefully examines your heart and the pulses of your neck, arms, legs, and feet. Your doctor may also use a stethoscope to listen to the pulses in your neck (carotid arteries) and your groin (femoral arteries). In some cases, a doctor can hear a “whooshing” or blowing sound (known as a bruit), which is the result of blood flow past narrowings in these arteries. Your doctor may ask you to remove your socks and shoes and will carefully examine your feet and toes to make sure you have not developed any ulcers caused by poor circulation.

If your doctor suspects that you have PAD, you will likely be asked to undergo the ABI test, which can be performed by your doctor, a nurse, or a medical assistant (Figure 1). You may also be sent to a vascular laboratory for the ABI test. During the ABI test, you will be asked to lie down on a stretcher. Blood pressures will be measured in your arms and legs with a special ultrasound device known as a Doppler. Normally, the blood pressure in the ankles is the same or slightly higher than the blood pressure in the arms. Because PAD-related blockages in the arteries limit blood flow to the legs, patients with PAD have low blood pressures in the ankles. Your physician will use the ratio of the leg

## Symptoms of PAD

### Common

- Buttock, thigh, or calf pain with exertion (claudication)
- No symptoms—diagnosed by abnormal ABI test
- Erectile dysfunction

### Uncommon

- Pain in legs and feet at rest
- Sore (ulcer) on leg that does not heal
- Arm pain with exertion (PAD of arms)
- Different blood pressures in the right and left arms of more than 15 points (PAD of arms)

pressure to the arm pressure (ankle blood pressure divided by arm blood pressure) to determine whether you have PAD. In some cases, the ankle pressures may be near normal, causing the diagnosis of PAD to be hard to make. If this is the case, the arm and leg pressures may be measured before and after you walk on a treadmill for a short period of time (stress test).

Your doctor may recommend that you undergo the ABI test even if you do not have leg discomfort or other symptoms of PAD. The ABI test can be used as a screening tool to diagnose PAD in patients without symptoms who have risk factors for atherosclerosis. You may be asked to undergo the ABI test if you are older than age 65, if you have diabetes, or if you are a tobacco smoker older than age 50.

In some cases, additional tests may be necessary to confirm the diagnosis of PAD or to determine the location of the blockages in the arteries. These tests may include an ultrasound of the legs, a computed tomogram (CT scan), or a magnetic resonance angiogram (MRI test). The blood pressures may also be measured at multiple locations along the legs in the vascular laboratory using 3 or 4 blood pressure cuffs on each leg.

### Importance of Diagnosing PAD

Doctors are recognizing that PAD is a much more common problem than originally thought. According to published research, more than 1 in 5 people older than age 70 have PAD. Fewer than half of the patients with PAD know they have a problem. Worse, many patients with PAD do not have leg symptoms and can only be diagnosed by a doctor's examination or by the ABI test.

Patients with leg pain caused by PAD may have a limited ability to walk, exercise, perform their jobs, go shopping, or clean their homes. Leg pain from PAD can worsen a person's quality of life. Many treatments for claudication are available that may greatly improve symptoms of PAD,

but the first step in treatment is diagnosis.

Most important, patients who have PAD likely have blockages in other arteries of the body, especially the arteries of the heart and brain. Patients with PAD are 3 to 6 times more likely to have a heart attack or stroke than are patients without PAD. If you are diagnosed with PAD, your doctor will work closely with you to decrease your risk of having a heart attack or stroke.

### Treatment Options for PAD

A number of treatment options are available to you if you have leg pain from PAD (claudication). You and your doctor should discuss which treatment is the most appropriate.

All patients with PAD need to quit smoking completely. Quitting cigarette smoking is difficult, but it may save your life. If you have PAD and continue to smoke, you are at increased risk of needing surgery or an amputation. Patients with PAD who continue to smoke also have a higher risk of dying from a heart attack or stroke as compared with those who quit. Your doctor will talk to you about the importance of quitting tobacco, and he or she may offer you a quit-smoking program, nicotine patches or gum, or a medication called bupropion (Zyban; GlaxoSmithKline). Quitting smoking is the hardest thing you will be asked to do, but it is critical.

Your doctor will likely recommend that you start an exercise program. In many studies, patients with claudication can more than double their walking distance in supervised exercise programs. Your doctor may suggest that you participate in a structured exercise program for patients with PAD or that you exercise on your own. Walking, whether around your neighborhood, at the mall, or on a treadmill, is the best exercise for patients with leg pain from PAD. If you do not have access to a supervised program, we suggest that you walk 4 to 5 times per week for 30 minutes (excluding rest stops) each time.

It is important that all patients with PAD take good care of their feet. Patients with PAD must avoid developing ulcers on the feet, as these may not heal properly because of poor circulation. Often, patients with ulcers that do not heal require a procedure to restore the circulation (see discussion about revascularization below). Patients with PAD should wear comfortable and appropriately fitting shoes. Women with PAD should avoid high-heeled shoes, as this type of footwear puts too much pressure on certain areas of the feet. Care of the toenails is especially important, and your physician may recommend that you make an appointment with a podiatrist. You should also examine your feet regularly to make sure you have not developed an ulcer. If you find an ulcer on one of your feet or toes, you should notify your doctor.

Your doctor may consider prescribing a medication to improve your ability to walk. There are two medications that have been approved by the Food and Drug Administration for the treatment of claudication: pentoxifylline (Trental; Aventis) and cilostazol (Pletal; Otsuka America Pharmaceutical). Research studies have suggested that cilostazol is more effective than pentoxifylline for the treatment of claudication. The side effects of cilostazol include palpitations, headache, and diarrhea. Only a small number of patients taking this medication will experience a side-effect. Cilostazol cannot be prescribed to patients who have had fluid in their lungs because of heart-pumping problems (congestive heart failure). Although cilostazol or pentoxifylline may improve your ability to walk farther, neither of these medications can cure the symptoms of PAD entirely. There are many clinical trials of new medical therapies for claudication.

For some patients with severe claudication that has not improved with smoking cessation, exercise, and a course of medication, their doctors may consider referring them to a vascular specialist for revascularization.

Revascularization refers to a procedure that restores blood flow in a limb that is supplied by blocked arteries. Patients with leg pain at rest caused by PAD and those with ulcers that will not heal should be referred for revascularization. The vascular specialist may be a vascular internist, cardiologist, vascular surgeon, or radiologist. The vascular specialist typically requests an additional imaging test, such as an ultrasound, MRI, or angiogram to determine the location of the blockages in the arteries and the best approach for revascularization. An angiogram is a test that involves injecting dye into the arteries while taking x-rays. It is an invasive test that may include an overnight stay in the hospital.

Revascularization can be accomplished by two approaches. In some cases, it may be possible to directly open the blockages in the arteries at the time of the angiogram. The blockages are opened with special balloon-tipped catheters. In most cases, a special metal scaffolding, known as a stent, is placed within the artery that has been ballooned open (Figure 2). This procedure is similar to the coronary angioplasty and stenting procedures that are performed on the heart for the relief of chest pain. For blockages that cannot be opened with angioplasty, the vascular specialist may recommend surgery. During vascular surgery, blocked arteries are bypassed with segments of a surface vein from the leg or from tubes of manmade materials (grafts). The vascular specialist will decide which revascularization approach is appropriate for each patient, after reviewing the case in detail.

### Preventing Serious Vascular Events in Patients With PAD

In addition to prescribing a treatment plan to improve claudication, your doctor will work closely with you to improve your overall cardiovascular health and decrease your risk of having a heart attack or stroke. This preven-

tion strategy will likely involve taking medications to prevent serious cardiovascular problems. Your doctor may prescribe a cholesterol-lowering medication (typically a statin drug), aspirin or clopidogrel (Plavix; Bristol-Myers Squibb/Sanofi Pharmaceuticals Partnership) to reduce the stickiness of platelets, and a medication to lower your blood pressure (such as an ACE inhibitor, beta-blocker, or calcium-channel blocker). In many cases, medications to lower cholesterol and treat blood pressure will be prescribed even if your cholesterol levels and blood pressure are not elevated. This is done because aggressive lowering of blood pressure and cholesterol can greatly reduce the risk of heart attack, stroke, and death in patients with PAD, regardless of whether the levels are elevated. Finally, your physician will

work with you to quit smoking if you have not already done so.

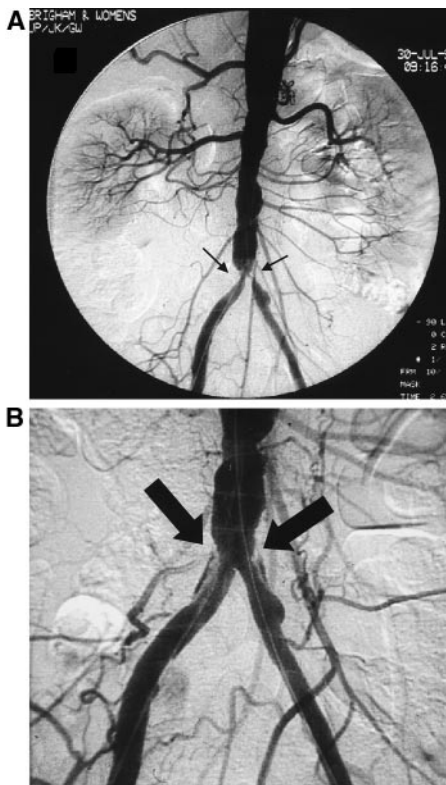
If you have PAD without symptoms and were diagnosed only because of an abnormal physical examination or ABI test, your doctor will emphasize the importance of preventing future cardiovascular events and will likely pursue a similar course of action.

### Additional Resources

American Heart Association. Diseases and Conditions. Peripheral artery disease. Available at: <http://www.americanheart.org/presenter.jhtml?identifier=3020242>. Accessed December 5, 2004.

Vascular Disease Foundation. Information for patients and health care providers on all aspects of vascular disease, with particular emphasis on PAD. Available at: <http://www.vdf.org>. Accessed December 5, 2004.

National Institutes of Health. National Heart, Lung, and Blood Institute. Information for patients on cardiovascular diseases, high blood pressure, and high cholesterol. Available at: <http://www.nhlbi.nih.gov/health/public/heart/index.htm>. Accessed December 5, 2004.



**Figure 2.** Angiogram of the iliac arteries before (A) and after (B) a revascularization procedure (angioplasty). This patient presented to his doctor with claudication in the buttocks. Both of the common iliac arteries (small arrows) were severely narrowed. Note the increase in the size of the arteries (large arrows) after angioplasty and placement of stents.