

CHAPTER 17

PERIPHERAL VASCULAR DISEASE

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Although the heart is the command center of the circulatory system, many medical conditions that afflict the heart may also or independently affect the network of arteries and veins that carry blood to and from the body's tissues. Such damage is generally referred to as peripheral vascular disease (PVD).

Arterial diseases may cause narrowing or blockage of vessels in the legs and other parts of the body distant from the heart (known as the periphery). Narrowing of the peripheral arteries happens in essentially the same way as narrowing of the coronary arteries. In coronary disease, the narrowing causes chest pain and, sometimes, heart attack. In peripheral arterial vascular disease, however, the most common symptoms are leg pains from decreased circulation. The veins, which send blood from the limbs and other tissues back to the heart, are also vulnerable to a variety of disorders that can cause blood clots to form or inflammation to develop,

HOW BLOOD CIRCULATES

The circulation of blood through the human body is divided into two interlocking systems: venous and arterial. Together, they keep a dynamic interchange of blood moving to and from the heart and lungs. (See Chapter 1 for a full explanation.)

Arteries carry freshly oxygenated blood from the heart to the rest of the body, starting in the central trunk artery, the aorta, which leads from the heart's main pumping chamber (the left ventricle). From the aorta, the arteries branch and divide into successively smaller vessels, and finally into tiny arterioles and capillaries that deliver oxygen to the body's tissues. Arteries are thick-walled and muscular; if an artery is cut, blood will spurt at high pressure and velocity with each beat of the heart. Arterial blood is scarlet, because it carries richly oxygenated red cells. Arteries such as the radial artery, located in the wrist near the thumb, are close to the surface of the body and are used to take the pulse.

Veins carry blood that has left much of its oxygen in the tissues back to the right side of the heart. It is then pumped into the lungs to pick up more oxygen. Compared to the flow of arterial blood, which is driven by the heart's powerful pumping, the flow of venous blood is relatively slow, returning from the lower body against the force of gravity. (A series of one-way valves inside the veins helps keep the blood from pooling or moving backward.) The flow of blood from a cut vein is slow and steady. Veins are thinner than arteries, and they appear bluish, because the blood they carry is low in oxygen.

The real work of the circulatory system—the exchange of nutrients for waste products—takes place in microscopic vessels called capillaries. These structures are as wide as a single cell and allow the dif-

MAJOR CARDIOVASCULAR DISORDERS

**Table 17.1
Diseases of the Veins**

Diseases	Causes	Symptoms	Treatment
Blood clots (venous thrombosis)	Sluggish movement of blood (stasis) Damage to the lining of the vein Inflammation of the vein (phlebitis) Abnormal tendency to form clots (hypercoagulable state)	Sometimes none; sometimes shortness of breath; coughing up blood-tinged phlegm if clot moves to lung (pulmonary embolism); marked pain and swelling in one leg	Anticoagulant and blood-thinning drugs such as warfarin (Coumadin) and heparin; in repeated cases, insertion of a filtering device to prevent pulmonary embolism; bedrest for 3 to 5 days with legs elevated; elastic stockings worn below the knee; moist soaks and anti-inflammatory drugs such as aspirin or indomethacin (Indocin)
Chronic venous insufficiency	Complication following deep-vein clot	Swelling and discoloration of one or both legs	Same as for blood clot; knee-length elastic stocking indefinitely to prevent swelling
Inflammation of the leg veins (phlebitis), superficial or deep (see blood" clots)	Infection or injury	Pain; redness; tenderness; itching; feeling of a firm cord in the calf or thigh	Anti-inflammatory drugs such as indomethacin (Indocin); analgesics such as aspirin bedrest and leg elevation; anti-itch ointment such as zinc oxide; moist heat
Pulmonary embolism	Deep-vein clot moved to lungs	Sometimes none; sometimes chest pain that worsens upon inhaling; sandpaper-like sound heard through stethoscope; shortness of breath; coughing up blood; increased pressure in the lungs (pulmonary hypertension)	Clot-dissolving (thrombolytic) drugs such as urokinase (Abbokinase), streptokinase (Kabkinase or Streptase); anticoagulants such as warfarin (Coumadin) or heparin; in rare cases, surgery to remove the clot
Varicose veins	Backflow of blood in the superficial veins in the legs because of faulty valves; pressure from standing too long or during pregnancy hormonal changes, during pregnancy, that dilate and relax veins	Sometimes none; sometimes pain; tingling or crawling sensation unsightly appearance	Surgical removal; avoiding standing for long; wearing elastic or support stockings

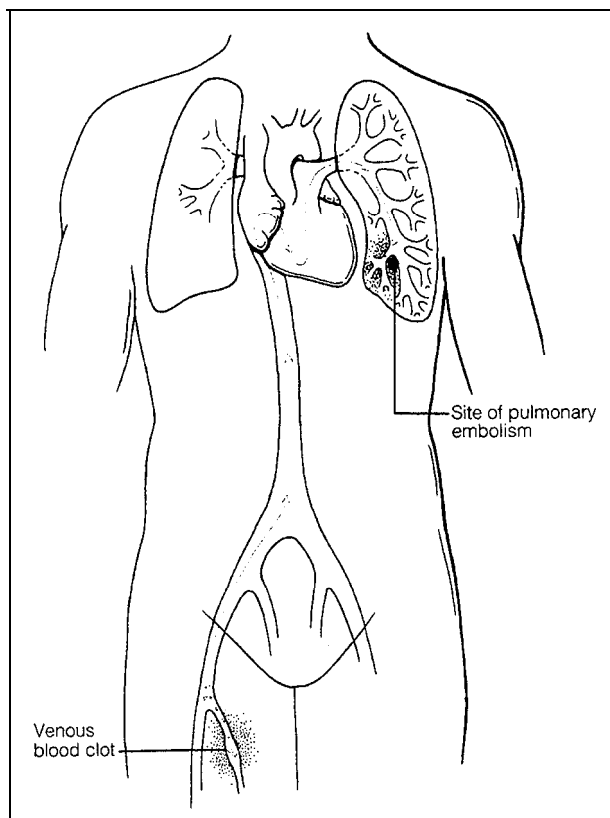
fusion, or passage, of oxygen and nutrients into organs and tissues. The two sides of the circulatory system come together in these tiny vessels. The capillaries terminate in the smallest of veins, which in turn channel blood into the larger veins and back toward the heart through the largest veins, the inferior vena cava (from the lower body) and the superior vena cava (from the upper body).

DISORDERS OF THE VEINS

Blood clot formation in the veins (*venous thrombosis*) is the most common—and most threatening—medical condition involving the veins. It afflicts an estimated 5 to 6 million Americans every year. (See Table 17.1.)

The primary danger of a blood clot in the deep veins of the legs (see Figure 17.1) and abdomen is the possibility that a portion of the clot may break loose (embolus), which can travel to the lungs, where it can

Figure 17.1
A blood clot that forms in a deep vein *in the leg* or abdomen *may travel* through the bloodstream and lodge in the lung, a serious condition called pulmonary embolism. The arrows indicate the path of the blood clot.



lodge in a pulmonary blood vessel. This is a serious condition called a pulmonary embolus, and if the blockage is large enough can be fatal. Blood clots in the superficial veins—those near the skin's surface—present little risk of embolization; they may cause localized pain and inflammation, but these symptoms can usually be treated with moist heat and medications such as aspirin. Clots in the deep veins in the calf are probably less threatening than clots in the deep veins above the knee, but, in either case, they must be treated aggressively.

Several conditions predispose a person to formation of blood clots in the veins. One is sluggish movement (*stasis*) of the blood in the veins of the limbs, especially the legs and feet. Damage to the lining of a vein, which may be caused by infection, injury, or trauma from a needle or catheter, can also be a factor. Inflammation of a vein (phlebitis), usually in the legs, is associated with clot formation as well. A third abnormality involves the blood's ability to coagulate too easily and form clots. This is called a *hypercoagulable* state. Injury to the inner lining of a vein causes platelets to congregate at the site, setting the stage for clotting when blood is sluggish or hypercoagulable.

Slow blood flow can be caused by any obstruction between the body's periphery and the heart. The massaging action of muscle contractions helps venous blood make its return trip; thus, a prime cause of slow blood flow is prolonged inactivity, which might occur, for example, as a result of a cast for a fractured bone in the lower extremity, extended bedrest after injury or illness, or even along car or plane trip. On long trips, it is a good idea for someone who might be predisposed to getting a clot in a vein to get out of the car or stand up in the plane every hour and walk around for one or two minutes. This advice is especially good for obese people or those with diabetes, heart disease, heart failure, or other circulatory problems. Smokers are also very susceptible to clot formation and inflammation of the veins and arteries.

Other less common causes of sluggish blood flow include certain tumors and a buildup of fluid in the abdomen (ascites). A host of conditions, including some cancers, inherited abnormalities, and the aftermath of a heart attack or surgery, can increase the blood's tendency to clot.

A deep-vein clot may cause no symptoms; the first indication of its presence, in fact, may occur after it has traveled to the lung (pulmonary embolism), causing a person to cough up blood-tinged phlegm and experience shortness of breath and chest pain. The clot may also result in marked pain and swelling

(edema) in one leg. Many other conditions, from joint diseases to heart failure, may cause pain or swelling in one or both legs. A carefully documented medical history and a few specific tests will usually lead to the diagnosis. Often a doctor can make the diagnosis merely by putting pressure on the calf or thigh muscle or flexing the ankle. If these maneuvers elicit a painful response, a deep-vein clot may likely be the culprit.

In most cases, the diagnosis must be confirmed using the test described below. The test considered the “gold standard” for diagnosing deep-vein clots is *contrast venography*. In this test, also called a venogram, a dye visible on an X-ray is injected into the veins of the feet; the patient is then tilted in various positions to facilitate blood flow from the lower veins to the heart, providing an X-ray image of the vein network. Venography is cumbersome and uncomfortable, and in a small percentage of tests, the results are questionable. The test also carries a small risk of infection or allergy to the dye. In many cases, the diagnosis can be made without this test.

Alternative tests include one in which blood flow in the legs is measured using a blood pressure cuff and two small electrodes. This quick technique, called *impedance plethysmography*, is useful for diagnosing clots above the knee. *Ultrasonography*, a completely noninvasive but relatively expensive technique, uses sound waves to form a picture of the veins and, in a variation called Doppler ultrasonography, measures blood flow. Other tests using radioactive isotopes may also be used. In one such test, called *platelet scintigraphy*, an injection of radioactively labeled platelets is used to locate clots and track their path through the veins over several days.

TREATMENT FOR VENOUS BLOOD CLOTS

After a venous blood clot has been discovered, a physician will first attempt to determine the underlying causes of abnormal clotting. Much of the time, the event causing the clot cannot be identified. However, clots that occur after long plane or car rides, surgery, or prolonged bedrest are relatively easy to explain. As a rule, immediate therapy consists of anticoagulant and blood-thinning medications such as warfarin (Coumadin) or heparin. The use of clot-dissolving (thrombolytic) drugs such as those now used to treat heart attacks is still considered controversial for clots in the veins, but may offer future promise. Lower doses of blood-thinning medications such as warfarin are usually continued for several months;

during this time, the bloods coagulation time must periodically be monitored (about every four weeks once it has stabilized) to guard against bleeding complications.

In patients who cannot take anticoagulants—for example, those with a bleeding ulcer or recent surgery patients—an umbrella-shaped filtering device may be inserted by catheter into the inferior vena cava, where blood from the legs is funneled back to the lungs, to prevent any major clots from reaching the lungs. This procedure usually is reserved for patients who have already experienced a clot or embolus to the lungs.

In addition to receiving medication, someone with a deep-vein clot should remain in bed during the acute attack (about three to five days), with legs elevated to prevent further swelling and facilitate venous blood flow. Moist heat and anti-inflammatory drugs such as aspirin or other, stronger nonsteroidal medications such as indomethacin (Indocin) may also be extremely helpful in controlling symptoms and aiding recovery. These should be used with care if in combination with anticoagulants. Once swelling improves, a firm elastic stocking should be worn *below* the knee whenever the person is out of bed. Most important, long periods of standing should be avoided.

In some people, a condition called *chronic venous insufficiency* may occur as a long-term complication following a deep-vein clot. It is characterized by swelling and discoloration of one or both legs. In these cases, a knee-length elastic stocking should be worn indefinitely to prevent swelling.

INFLAMMATION OF THE VEINS (PHLEBITIS)

The most common form of phlebitis is an inflammation of the superficial veins in the leg, usually caused by an infection or injury. The affected vein may appear reddened and feel like a firm cord in the calf or thigh. The condition is painful and is treated with moist heat and analgesics such as aspirin or some other nonsteroidal anti-inflammatory drug such as indomethacin (Indocin). Itching may be relieved by a nonprescription ointment containing zinc oxide.

The chief danger of phlebitis is an increased risk of clot formation and embolization, especially when it occurs in the deeper veins. Deep-vein phlebitis may cause the same symptoms as deep-vein thrombosis. There may be severe pain, tenderness, and fever.

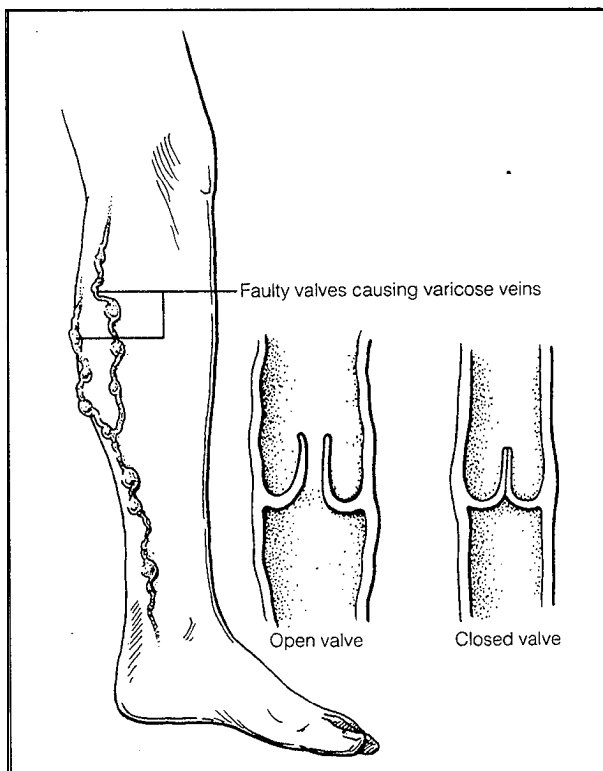
VARICOSE VEINS

Normally, blood returns to the heart at a steady pace, helped along by exercise and by the veins' internal valve system. The valves act as one-way gates to prevent blood from pooling; they aid in moving blood against the force of gravity. If blood flow is too slow or the valves are damaged or ineffective, however, veins in the legs—especially superficial vessels in the lower legs—can swell, bulge, and twist into varicose veins, or varicosities. (See Figure 17.2.) Heredity of poorly functioning or absent valves seems to be a major factor. People who spend a lot of time standing are especially prone to varicose veins. Women may get them for the first time during pregnancy, because of pressure from the fetus on the veins in the abdomen (into which the leg veins drain) and hormonal changes that dilate and relax the veins.

Although varicose veins can cause pain or a sensation of tingling or crawling, they often produce no symptoms. However, they are considered unsightly. The condition can be corrected surgically in a procedure called “stripping,” during which the varicose veins are simply tied off at intervals through skin incisions and pulled out from under the skin. (Nearby veins adapt by creating alternative pathways for the return of blood.) Alternatively, the varicose veins

Figure 17.2

Varicose veins develop when the one-way valves in the superficial veins in the legs do not close properly, allowing blood to backflow and pool.



may be injected with an irritating (sclerosing) substance, which causes them to shrink. Again, nearby veins assume the blood flow. Individuals with varicose veins should remain as thin as possible to reduce “back pressure” on the veins and should avoid standing for long periods of time. Elastic or support hose may provide some assistance to return blood flow, but tight garters, which impede circulation, should be avoided. Many people who have varicose veins do well and experience no limitations other than some swelling.

PULMONARY EMBOLISM

The closer to the heart that a clot is formed, the more likely it is to migrate to the lungs and form a pulmonary embolism. Such a clot may be fatal. It is also one of the most difficult causes of sudden death to diagnose. In some instances, there are no symptoms at all. In others, however, it may produce a variety of symptoms and signs, such as chest pain that worsens when a person inhales, a sandpaper-like sound heard through the stethoscope, shortness of breath, and coughing up blood. The embolism may resolve, leaving no permanent damage, but it can damage lung tissue or cause fluid buildup in the lung cavity. For instance, increased pressure on the right side of the heart over long periods of time may cause increased blood pressure in the vessels in the lungs, a condition known as pulmonary hypertension.

To diagnose a pulmonary embolus, a physician measures the levels of oxygen in the arteries and performs other tests to determine how well the lung is ventilated with air and supplied with blood. An obstruction to the lungs' blood supply, indicated by a lower percentage of oxygen in the blood, suggests the possibility of a clot. The diagnosis is confirmed by pulmonary angiography, in which the pulmonary artery is injected via a catheter with a dye so it will appear on an X-ray. The treatment for pulmonary embolus may involve clot-dissolving (thrombolytic) medication such as urokinase (Abbokinase) or streptokinase (Streptase), anticoagulants such as warfarin (Coumadin) or heparin, or other blood thinners; in rare cases, surgery is necessary to remove the **clot**.

PERIPHERAL ARTERIAL DISEASE

The coronary arteries that encircle and nourish the heart are the most common targets for the damage

caused by atherosclerosis, the blockage of arteries with fatty deposits. However, atherosclerosis can affect arteries virtually anywhere in the body. When it occurs in the neck or the brain, it can cause a stroke. (See Chapter 18.) In the arteries supplying the legs, it can cause pain and, in a small minority of cases, tissue damage so severe it results in gangrene and amputation.

Atherosclerosis in the peripheral arteries is similar to that in the heart: Blood-borne fats, or lipids, infiltrate a damaged area of the vessel wall and cause further damage and thickening with the formation of a plaque. The inside passage of the artery becomes narrowed and may be blocked completely by a blood clot. This leads to *ischemia*, a condition in which arterial blood flow is impeded, resulting in too little oxygen being delivered to the tissue “downstream” from the narrowing or obstruction. The risk factors for arterial blockage in the periphery are identical to those for blockage in the coronary arteries, including high blood cholesterol, cigarette smoking, diabetes, and high blood pressure. Smoking is a particularly important risk factor for peripheral artery disease.

The classic symptom of peripheral arterial disease is crampy leg pain while walking, called *intermittent claudication*. Pain may worsen when a person walks faster or uphill. The pain usually stops when he or she rests. The cause is ischemia in the working muscles, a sort of “leg angina.” (Angina pectoris, or chest pain, is usually caused by inadequate blood supply to heart muscle.) The pain of claudication is most often triggered by exercise, but maybe brought on by other factors, including exposure to cold or certain medications, such as some beta blockers, that constrict blood vessels and decrease peripheral blood flow.

The location of the blockage determines the symptoms. If the obstruction is relatively low in the arterial branches supplying the legs, calf pain may be the result; higher blockage may cause thigh pain; and blockage higher than the groin (in the blood vessels in the abdomen) may also cause buttock pain and impotence,

When arteries are badly narrowed—or blocked altogether—leg pain may be noticed even when resting. At this point, the legs may look normal, but the toes may appear pale, discolored, or bluish (especially when the legs are dangling). Feet will feel cold to the touch. Pulses in the legs may be weak or absent. In the most severe cases, blood-starved tissues may actually begin to die. Lower-leg, toe, or ankle ulcers may occur, and in the most advanced cases, gangrene may result and necessitate the amputation of toes or feet.

Foot Care for People with Peripheral Vascular Disease

Poor circulation caused by peripheral vascular disease makes feet more vulnerable to injury and infection and slower to heal. For this reason, it is especially important to take proper care of the feet to avoid complications. Here are some tips:

- Inspect feet daily for calluses, ulcers, and corns.
- Wash feet gently each day in lukewarm water and mild soap (this can be part of a bath or shower); dry thoroughly but gently.
- If skin is dry, thin, or scaly, use a gentle lubricant or moisturizing lotion after bathing.
- To avoid fungal infection such as athlete’s foot, use a plain, unmedicated foot powder.
- Cut toenails straight across and avoid cutting close to skin. If your eyesight or manual coordination is poor or you have trouble reaching your feet, have a family member or a podiatrist trim the nails.
- If you have calluses or corns, have them treated by a podiatrist. Avoid adhesive plasters, tape, chemicals, abrasives, or cutting tools.
- Wear sensible, properly fitted shoes; avoid high heels, open-toed shoes, sandals, and walking around barefoot. If any foot problems are present, such as bunions or hammer toes, have shoes specially fitted to avoid rubbing or blisters.
- Keep feet warm in cold weather with loose-fitting wool socks or stockings, but avoid using hot-water bottles or heating pads directly on feet. (Poor circulation can reduce sensation in the feet, making a burn more likely.)

However, such serious complications of peripheral arterial disease are uncommon.

Patients with poor circulation to the feet and toes should discontinue smoking if applicable, and pay particular attention to avoiding injury to those areas. Otherwise healing will be slower and infection more likely. (See box, “Foot Care for People with Peripheral Vascular Disease.”) Feet should be kept warm, dry, and away from excessive heat (baths, heating pads), and avoid cutting toenails too short. Since peripheral arterial disease is more common in individuals with diabetes than in those with normal blood sugar, control of diabetes is important.

DIAGNOSIS AND TREATMENT

Other conditions, including various joint, muscle, and lower-back problems, can also cause a person to experience leg pain while walking. With peripheral arterial disease, however, the presence of typical symptoms—pain in the calf or thigh while walking that ceases upon stopping—and decreased pulses in the arteries in the feet are sufficient to make the diagnosis in most cases.

Decreased hair on the lower extremities indicates a chronic problem. Taking cuff measurements of blood pressure in the ankles or in other segments of the legs may help determine how much blood is getting to the feet. Tests may be performed before and after exercise. The diagnosis of peripheral arterial disease may be made using Doppler ultrasonography to see blood flow in the arteries, magnetic resonance imaging (MRI) to identify obstructions, or—most important—angiography. These procedures are expensive and are not necessary in most cases. Because angiography is an invasive procedure involving the injection of dye into the arteries, it is usually reserved for cases when surgery or angioplasty is a likely option. For example, in cases of severe claudication with evidence of poor circulation, discoloration, absent pulses, and cold extremities, angiography can determine the best course of treatment.

It has been estimated that 80 to 90 percent of patients with claudication will stabilize or improve with time. Perhaps 10 to 15 percent will require some type of interventional therapy; less than 3 to 5 percent will require amputation. In treating peripheral arterial disease, conservative measures should be given a fair trial before *any* invasive procedures are considered.

Several steps are essential: control of obesity and diabetes if present, the cessation of cigarette smoking (the majority of peripheral arterial disease sufferers are smokers), and adherence to a program of regular exercise, such as daily walking. Patients may typically be instructed to walk for a half hour to an hour a day, walking until the pain comes on, resting until it abates, then continuing to walk. Often such a walking regimen can increase the distance of pain-free walking, thanks to increased fitness and perhaps the development of alternate circulation paths through surrounding smaller vessels, called collateral circulation. Control of the risk factors for “hardening of the arteries,” including elevated blood pressure and cholesterol, if present, is also extremely important.

Other forms of exercise, such as swimming or using an exercise bicycle, may also be helpful, partic-

ularly to people with other joint and muscle problems for whom strenuous weight-bearing exercise (such as jogging) could present a significant risk of injury. People with symptoms of peripheral arterial disease should consult a physician before taking up any new exercise program.

Anticlotting agents, such as an aspirin taken each day, and vasodilator drugs, such as hydralazine (Apresoline) or prazosin (Minipress), may be used to treat peripheral arterial disease. (Most of these reedifications, however, have not been proved effective.) An agent called pentoxifylline (Trental) is also available for the pain of claudication. (Beta blockers, often used for other cardiovascular conditions, may make peripheral arterial disease worse.) If these measures fail to halt peripheral arterial disease, and disability is severe or limbs are threatened, invasive techniques such as angioplasty or surgery may have to be used to open blocked arteries, but this is uncommon.

ANGIOPLASTY AND SURGERY

Balloon angioplasty is being used successfully to open blocked arteries in the legs of people with severe cases of peripheral arterial disease. The procedure, usually performed by a radiologist or cardiologist, is similar to that used in the heart. A balloon-tipped catheter is inserted through the skin and threaded through the arteries to the site of the blockage. When the balloon is inflated, it flattens the obstructing plaque against the artery walls and, ideally, widens the passageway for blood.

Balloon angioplasty is most successful on peripheral blockages that are relatively short and well-defined, rather than those that are long or scattered. For peripheral arterial disease, it has proved safe and effective for appropriately selected patients, offering the advantage of faster recovery time than that of bypass surgery. It usually requires only one to two days of hospitalization. However, in about 30 percent of all cases, the leg arteries become relogged (called restenosis) within a year or two, and angioplasty or surgery may eventually be necessary again. In addition to balloon angioplasty, a variety of new catheter techniques are under investigation for use in the heart and the peripheral arteries, including devices that shave out plaques and laser tips that burn through them.

One surgical option for people with severe blockage involves opening the blocked vessel and stripping the plaque out, a procedure called endarterectomy.

Another is bypass surgery, in which a patient's own vein or a synthetic equivalent is grafted onto the blocked artery so that blood can flow around the obstructed area. The physician's thoughtful evaluation of an individual's profile as a surgical candidate is crucial in deciding upon the optimal treatment.

What makes an individual an appropriate candidate for angioplasty, surgery, or other procedures? As a rule, the potential benefits of intervention must clearly outweigh the risks. Patients with mild intermittent claudication are *not* candidates for surgery or catheterization. People with tissue damage or those who experience severe pain while at rest, however, may require opening of clogged arteries (revascularization) to avoid disability. Between these two extremes, individuals with severe intermittent claudication may benefit from angioplasty or even surgery if the blockages are of a type that can be readily corrected. (See Chapters 24 and 25.)

If major surgery is contemplated for peripheral vascular disease, a full cardiologic evaluation should be ordered. This is recommended because people with peripheral vascular disease may also have coronary artery disease, which may pose an additional risk that should be evaluated and treated appropriately.

AORTIC ANEURYSM

An aneurysm is a weakened area of a blood vessel wall that balloons outward and threatens to rupture.

Figure 17.3

In a dissecting aneurysm, the inner and outer layers of an artery separate, and blood pools between the layers, causing a swelling of the wall.

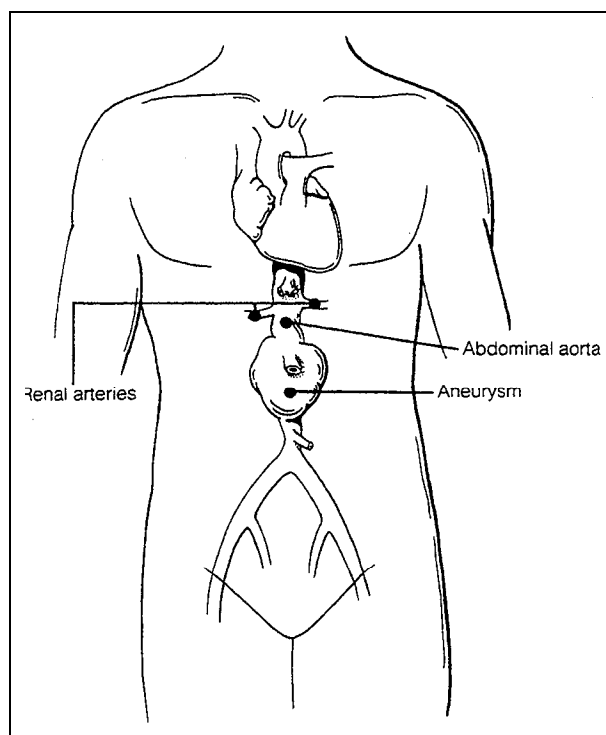
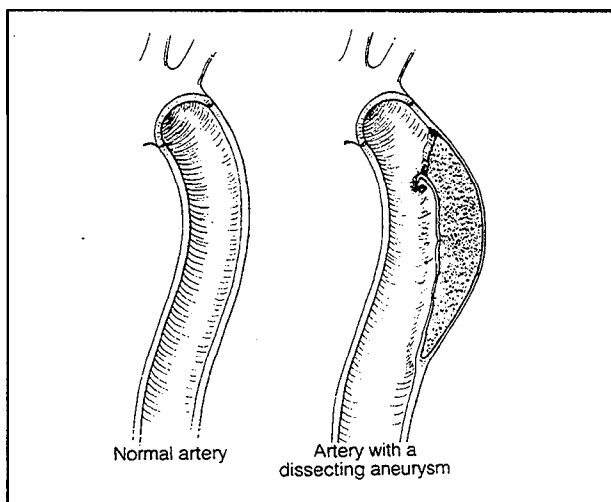


Figure 17.4

An aneurysm is the result of a weakening of an artery that causes it to balloon out. The most common site is in the abdominal aorta below the renal arteries.

In the aorta, the main artery leading away from the heart, such a rupture can have devastating consequences, flooding nearby tissues with blood and markedly reducing the supply of blood to the rest of the body, leading to possible immediate death if not treated promptly.

Aortic aneurysms generally fall into three categories. The walls of arteries consist of three tissue layers, with the middle muscular layer providing structural support. If an aneurysm forms as a result of damage to the middle layer, it is a *saccular aneurysm*. A *fusiform aneurysm* may form when the entire circumference of a section of the aortic wall is damaged. If the layers separate as a result of high blood pressure and blood is forced between them, causing the outer wall to swell, it is called a *dissecting aneurysm*. (See Figure 17.3.)

An aortic aneurysm may occur below the renal arteries that supply the kidneys, in the abdominal area (see Figure 17.4), or in the chest (thoracic) area at the arch of the aorta where it first branches off from the heart. The aneurysm is usually caused by atherosclerotic damage to the vessel wall, which weakens its structure. Hypertension may accelerate the process. It may also result from genetic or congenital conditions, such as Marfan syndrome, an inherited disease.

An aneurysm may cause no symptoms, or it may cause abdominal or chest pain. Large aneurysms can also produce more symptoms because they may apply pressure to adjacent blood vessels, nerves, and organs. In these cases, symptoms may include hoarseness, coughing, difficulty swallowing, or shortness of breath.

Perhaps most often, an aneurysm is detected as a result of a routine chest X-ray or when a physician palpates the abdomen. Echocardiography, computed tomography (CT) scan, and magnetic resonance imaging (MRI) are techniques that can define the size and location of an aneurysm quite precisely. (See Chapter 10.)

The larger the aneurysm, the more likely it is to rupture. Surgical repair is usually imperative for large aneurysms or aneurysms that are expanding. For this reason, patients with small aneurysms are monitored regularly with full exams and imaging techniques. (Patients who spontaneously rupture the aneurysm usually die suddenly.)

Corrective surgery requires clamping the aorta and repairing the affected segment with a woven Dacron patch or graft. The strain on the heart that results when the aorta is clamped presents serious risks of its own in people with cardiovascular disease. For this reason, a person with significant associated coronary artery blockage should be carefully evaluated and may be advised to undergo coronary bypass surgery or angiography before the procedure to repair an aortic aneurysm.

OTHER ARTERIAL DISORDERS

RAYNAUD'S PHENOMENON

This vascular disorder is characterized by intermittent coldness, blueness, numbness, tingling, or even pain in the fingers and toes. (Usually it affects both hands simultaneously and the same fingers of each hand.) It is more common in women, who account for 60 to 90 percent of all cases, and those who are thin and high-strung seem to be most vulnerable. Caused by excessive constriction of the tiny arteries that nourish the fingers and toes (vasospasm), it may be triggered by a number of factors, particularly exposure to cold temperatures, emotional stress, smoking cigarettes, and activities such as swimming. When the hands are gradually warmed, normal color and sensation return, often accompanied by some

redness and tingling as the blood flows back into tissues. People with this disorder should not apply too much heat to the affected fingers and toes; the use of moderate heat will be effective without the danger of tissue injury.

Raynaud's phenomenon may be associated with various connective tissue disorders, such as rheumatoid arthritis or lupus erythematosus, but in a majority of cases the underlying cause is unknown; when there is no other primary cause, the condition is known as Raynaud's disease.

Treatment of Raynaud's can be difficult and frustrating. Various approaches to drug therapy are under investigation, many of them directed at influencing the biochemical factors that constrict or relax the smooth muscles in the walls of the arteries. Although totally effective drug treatment remains elusive for many sufferers, many others are helped significantly with a calcium channel blocker such as nifedipine. The use of phenoxybenzamine (Dibenzyl-line), a medication that blocks the effects of adrenaline on blood vessels, may occasionally produce relief of symptoms. (Some beta blockers may aggravate symptoms.)

Usually, therapy consists of measures such as avoiding exposure to cold and wearing thermal gloves and thick socks. Because smoking causes blood vessel constriction, tobacco use should be discontinued. Biofeedback has had mixed results in relieving symptoms. Most individuals with the disease learn to live with it and, when possible, to avoid situations that cause it, but this cannot always be done.

Raynaud's disease doesn't usually cause tissue death, but over a long time, it may cause the skin of the fingers to become shiny and tight-looking, possibly with small ulcers caused by repeated ischemia. In advanced cases, the lining of the small arteries may thicken, and clotting may result, but this is rather rare. When Raynaud's phenomenon is caused by another disorder (such as lupus), effective treatment of the underlying condition may provide relief.

BUERGERS DISEASE

This relatively rare condition, also called *thromboangiitis obliterans*, occurs overwhelmingly in men aged 20 to 40 who smoke cigarettes. (Only about 5 percent of all cases occur in women.) The disease causes inflammation in the small and medium-sized arteries and veins and eventually produces irreversible changes in the muscle walls of the blood vessels. It's a type of smoking-induced peripheral arterial dis-

ease, and the resulting ischemia can be so severe as to warrant amputation of fingers and toes. All smokers experience some degree of clamping down of the peripheral blood vessels (vasoconstriction). It is unknown why people with Buerger's disease experience this to such a severe degree. Genetic or autoimmune defects have been suggested as possible explanations for this condition.

Treatment consists of giving up smoking completely as soon as possible. Other measures may be taken to improve blood flow and treat tissue damage, but without the cessation of cigarette use, progression of the disease is likely.

LIFE-STYLE MEASURES

The well-publicized campaign to control cardiovascular risk factors has already made progress in re-

ducing the toll from heart disease. Unfortunately, the effects of atherosclerosis on the rest of the cardiovascular system have received less attention. Anyone with peripheral arterial blockage, however, is suffering from essentially the same disease, and it is just as important for him or her to control high blood cholesterol, high blood pressure, diabetes, and obesity, and to stop smoking, as it is for the patient with heart disease. (Often, heart disease and peripheral arterial disease occur together—and one should be a warning that risk factors are present for the other.)

Too often, treatment of peripheral vascular disease has neglected to include alteration of life-style risk factors such as cessation of smoking, a low-fat and low-cholesterol diet, regular moderate exercise, weight control, maintenance of appropriate blood pressure, and control of diabetes. To prevent the recurrence or progression of symptoms, implementing these measures must be an integral part of any treatment plan.