ProCare Training Manual
Chapter 6
Vascular Ulcers

Venous ulcers occur on the lower leg and affect approximately 1% of the population as a whole, but are more common in older adults, affecting approximately 3.5% of the population over age 65.

The vascular system consists of your arteries, veins, capillaries and lymphatics. The group of disorders that affect this system is known as PVD (peripheral vascular disease). Vascular ulcers are open wounds that are caused by PVD in the venous, arterial, and lymphatic systems. Venous and arterial wounds are most common in the distal lower extremities, whereas lymphatic ulcers occur in the arms or legs.

In the lower legs where venous ulcers develop there are three major types of veins, superficial veins, deep veins, and perforator veins.

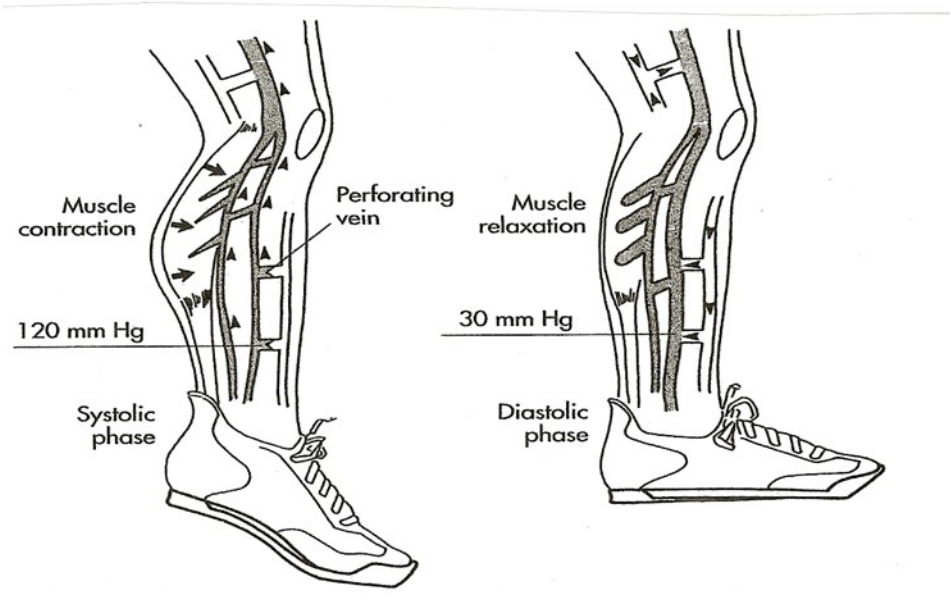
1) Superficial veins - These veins lie just beneath the surface of the skin and drain into deep veins through perforator veins. Varicose veins are superficial veins that have become stretched and tortuous.
2) Perforator veins– These veins connect the superficial veins to the deep veins.
3) Deep veins – These veins receive the blood from the perforator veins and return it to the heart. Each of these veins parallels a corresponding artery.

Veins vs. Arteries

The difference between veins and arteries is quite notable. If you have a vein and an artery of the same size the vein will have a thinner wall and a wider diameter. Vein walls have three distinct layers: an inner layer (tunica intima), a middle layer of smooth muscle (tunica media) and an outer supportive layer (tunica adventitia). Veins also have valves that open toward the heart. The valves keep the blood flowing in one direction, toward the heart. Deep veins have more valves than superficial one, and veins in the lower legs have more valves than those in the upper leg.

The calf muscle also plays an important role in circulation. When the calf muscles contract they squeeze veins in the legs forcing venous blood toward the heart. When the muscles relax, veins in the leg expand and refill the blood from superficial and perforator veins.

Figure 6-A Calf muscle assisting with pumping



When the flow of venous blood slows, blood pools in the veins of the lower limbs, and venous pressure rises. As the disease progresses, blood backs up through the perforator veins into the superficial veins, causing varicose veins to develop in the superficial system (however, just because a person has varicose veins does not mean that they have venous insufficiency). In many cases, edema develops as excess interstitial fluid accumulates. Venous ulcers can develop from this venous hypertension.

Venous ulcers are most frequently found on the lower leg and around the ankle, especially the medial ankle. These ulcers may extend all the way around the leg. Most have irregular shapes with dry and crusted borders or slightly moist borders due to maceration from drainage. The venous ulcer is typically shallow with a beefy red granulation base.

When assessing a patient with venous insufficiency you may see a brown pigmentation. This is due to red blood cells, fluid, and fibrin leaking into tissues. Always note the color of the patient's skin. Hyperpigmentation is a common problem with these patients even when ulcers aren't present. This color change is due to the buildup of hemosiderin in the interstitial tissue as the RBC's that have leaked into the tissue break down.

The fibrin causes skin and subcutaneous tissue to thicken and become fibrotic, a condition known as lipodermatosclerosis. It is important to realize that once the hemosiderin has occurred, it often a permanent condition. In advance lipodermatosclerosis, the skin develops hardened, scaly crust like cells that are firmly adhered. It is important that this skin be thoroughly re-moisturized before attempting to debride any portion of it. Due to the

interruption of appropriate blood supply, debriding these calcifications often leads to the development of new wounds. It is best to allow the body to slough off this tissue.

Venous ulcers are the result of venous hypertension, in which there is venous insufficiency. Usually, the reason for the insufficiency is that the valves are not working as they should. Valve incompetency may be caused by a thrombus that keeps the valves from being able to close.

Figure 6-B Hemosiderin and Lipodermatosclerosis

Typical location and appearance of venous ulcer. Hemosiderin staining in well moisturized skin.

Venous dermatitis. Notice extensive hemosiderin staining and lipodermatosclerosis.

Other skin changes characteristic of venous insufficiency include edema, eczema, and atrophie blanche:

- Edema is one of the first signs of venous disease
- Eczema is common, especially in patients who have recurrent ulcers
- Atrophie blanche may appear as spots of ivory-white plaque in the skin, usually surrounded by hyperpigmentation

Testing for Venous Insufficiency

Diagnostic testing for venous ulcers include plethysmograpy, venous duplex scanning and venography.

Plethysmography – records changes in the volumes and sizes of extremities by measuring changes in blood volume. There are two types:

1) Air Plethysmograpy which uses an inflatable pneumatic cuff placed around the limb to obtain volume measurements and standing and walking pressures.
2) Photoplethysmography – uses infrared light transmitted through the skin to measure venous reflux and filling rimes.

Venous duplex scanning – used to assess venous patency and reflux by measuring and recording venous pressures along an extremity as its veins are compressed and released.

Venography – is the radiographic examination of a vein injected with a contract medium

Treatment of venous ulcers – Effective treatment of venous ulcers involves good wound care while managing the underlying venous condition. Controlling edema is the most important goal in managing chronic venous insufficiency.

Elevation of the limb is also effective in reducing edema in the leg. Elevate the leg and allow gravity to drain fluid from the limb. This is best accomplished with the patient in bed with his legs elevated above his heart. However, any elevation can be helpful.

Compression therapy – There are various rigid and flexible bandages for compression. The first thing before choosing a dressing is assessing the ankle brachial index (ABI) to ensure the adequacy of arterial supply. See instructions for doing an ABI provided by 3M Health Care included.

Unna's boot – One of the oldest treatments for venous ulcers is the Unna's boot. This dressing is especially useful for patients who pick at sores, because it renders the ulcer inaccessible. The dressing should be changed weekly, or more frequently if needed.

The Unna's boot consists of a roll of gauze that is impregnated with zinc oxide, calamine, and glycerin and placed over the skin from below the toes to just below the knee.

The dressing conforms to curvatures in the leg and any concavity is filled with additional dressing. The dressing is occasionally covered with cotton batting to pad the wound and to absorb drainage. An elastic bandage (such as Coban or Ace) is wrapped around the outside to provide compression. As the dressing dries it becomes semi-rigid.

Although the Unna's boot provides compression, protection and a moist environment for the wound it's most important feature is its rigidity. Calf muscle contractions are key to the effectiveness of the Unna's boot. As the patient walks, the rigid dressing restricts outward movement of the calf muscle, directing more of the contraction force inward and improving the function of the calf muscle. Therefore, the Unna's boot is not as effective for a sedentary or bedridden patient.

If the patient complains of pain with the Unna's boot try placing a hydrocolloid or foam dressing over the ulcer before applying the boot.

Stockings – Compression stockings are a staple for long-term management of lower leg venous disease. They are available in four classes of pressure, as measured at the ankle. These patients can be measured for stockings in the clinic or sent to the local DME for the measurements. It can be very difficult for some patients to be able to put on the stockings, especially if they are obese, have arthritis or back problems. In this case, there are devices that have been developed to assist with the application of pressure stockings. One alternative to a piece stocking is the CircAid Thera-Boot which provides approximately 20 to 40 mm Hg of compression is easier to put on than stockings. The boot is made on a semi-rigid material and has easy-to-use straps that secure the dressing in place. The dressing is washable and reusable and can be removed at night.

Elastic Bandages – These are inexpensive bandages that can be used for compression. They come in short-stretch and long-stretch. Ace wraps are not generally classified as a compression wrap as it difficult to achieve and maintain the graduated pressures.

Short-stretch - A short-stretch bandage has limited stretch, usually less than 90% of its length. When stretched to its limit, the bandage becomes semi-rigid, proving compression, while the patient is active. When the patient relaxes it provides less compression.

Long-stretch - A long-stretch bandage stretches to more than 140% of its length. This type of bandage provides low working pressure and high relaxing pressure. It exerts a certain amount of pressure at all times, however when the patient is active or resting and may provide more pressure than is desired during periods of rest.

Graduated Compression – These stockings provide a pressure gradient that's greatest at the ankle and lowest at the top of the stocking. This compression gradient is consistent with the hydrostatic pressure in leg veins, which is greatest at the ankle and less at the upper leg. These stocking exert 100% of their pressure at the ankle, 70% at the calf and 40% at the thigh. This gradient helps reduce venous reflux.

Compression pumps may be used in conjunction with support hosiery. They have sleeves that intermittently inflate and may have separate bladders that inflate sequentially.

Medication – Medications aren't usually given for venous ulcers unless there is an infection present, in which case oral antibiotics are usually prescribed. Diuretics shouldn't be prescribed to treat edema in cases of venous insufficiency because edema is typically treated in these cases with compression and elevation. However, if the patient has a heart condition they may be receiving diuretics for that condition and should be monitored closely for volume depletion or other serious metabolic disorders.

Surgery - Venous ulcers are a chronic condition and are slow to heal and recur often, thus surgery is rarely an option for these patients. While skin grafting may be a temporary solution it is not usually successful due to the underlying problems with venous hypertension.

Valve transplants are not usually an option for these patients. By the time a patient gets venous ulcers replacing a single valve is usually of little value.

SEPS – (Subfascial endoscopic perforator surgery) This surgery is performed on the incompetent perforator veins, they are located and ligated, redirecting the blood flow to healthy veins and improving ulcer healing.

Other Treatments - Apligraf can be used on venous ulcers and has been shown to heal ulcers in about 4 weeks of treatment, also growth factors have been successful in improving the rate of healing in venous ulcers.

Arterial Ulcers

Arterial ulcers are also known as ischemic ulcers, they are the result of tissue ischemia due to arterial insufficiency. They can occur at the distal end of any arterial branch and account for up to 20% of all leg ulcers.

The arteries consist of three layers: the tunica intima (innermost layer), the tunica media (middle layer) and the tunica adventitia (the outermost layer). The arteries carry blood to every functioning cell in our bodies, their strong, muscular walls allow arteries to expand and relax with each heartbeat. Arterial insufficiency occurs when arterial blood flow is interrupted by an obstruction or by narrowing of an artery (arterial stenosis). An occlusion can occur in any artery, and will in time lead to an arterial ulcer. The most common cause of occlusions is atherosclerosis. Patients at high risk include cigarette smokers, diabetics, the elderly, and those individuals with hyperlipidemia or hypertension.

Many times a patient will not know they have an arterial insufficiency until they suffer an injury and the blood flow to the site of the injury is greater than an occluded artery can deliver, ischemia occurs and pain follows. The primary symptom of ischemia is pain and it is often severe. The pain may progress from claudication to rest pain.

Claudication is when the leg muscle have insufficient oxygen supply and they experience pain. It has been described as "angina of the leg muscles". Claudication can occur in any muscle distal to the occluded artery, it is brought on by exercise and is relived by rest. Most patients report claudication pain in the calf, thigh, or buttocks. It's measured by how many city blocks the patient can walk before needing to stop. As the arterial insufficiency worsens, the distance a patient can walk shortens and eventually, the patient feels pain even when resting.

Rest pain is usually reported in the foot and can occur even when the patient is sleeping. It may be relieved by lowering the leg in order for gravity to help the blood flow into the foot and calf, reducing the oxygen deficiency. By the time rest pain occurs, tissues are severely ischemic and the patient may face the risk of amputation.

Assessment of Arterial Ulcers

Assessment of arterial ulcers begins with a complete patient history and physical exam. The history should include pain, the type of pain (intermittent claudication , resting, etc.)

Ask if they experience pain at night; and, does dangling the foot over the edge of the bed relieve it? Ask about smoking as well (how much, how long).

The physical examination should begin by inspecting the common sites of arterial ulcers: the tips of toes, the corners of nail beds , bony prominences, and the area between the toes.

Because there is little blood flow to these ulcers they are usually pale and dry, with little or no granulation tissue present. The edges are often well defined and have a "punched out" appearance to them. They may have an area of wet necrosis or a dry scab. The skin surrounding the ulcer typically feels cooler than normal upon palpation.

Figure 6-C Diabetic/Arterial Ulcer

Signs of arterial insufficiency

Arterial ulcers commonly occur in the area around the toes. The foot usually turns deep red when dependent and the nails may be thick and ridged. The pulses may be faint or absent, the skin cool, pale and shiny, and the patient may report pain in his legs and feet.

Elevate the foot with the ulcer to a 30-degree angle; the skin color in an ischemic foot pales. Then ask the patient to place his foot in a dependent position. Ischemic skin becomes deep red as the tissue refills with blood. This change is called "dependent rubor" and is a sign of severe tissue ischemia.

A full exam will need to be done by the physician. Palpation of the abdominal aorta for the presence of an aortic aneurysm. An embolus can occlude an artery and cause ischemia, and an aortic aneurysm may be the source of the embolus. "Blue toe syndrome" a painful ischemic toe, is caused by embolic debris in the arteries that supply the toe.

Palpate the femoral, popliteal, posterior tibial, and dorsalis pedis pulses in each leg and compare your findings. Keep in mind that an absent dorsalis pedis pulse may not be an abnormal finding. Under normal conditions, some patients don't have a palpable dorsalis pedis pulse. Pulses can be palpated when the pressure is about 80 mm Hg. Pulses aren't always palpable in a foot with an arterial ulcer. This is largely dependant on the degree and location of arterial occlusion.

Compare the color of both legs and palpate each for temperature. A difference in temperature of 10 degrees or more can be noted by palpation. Have the patient lie down, elevate both his feet about 12" or to a 30-degree angle. Watch for a color change. Compress the great toe bilaterally and compare the capillary refill on each side. Normal tissue should refill in less than 3 seconds.

Diagnostic Tests

Tests used to diagnose arterial flow to the extremities include Doppler ultrasonography, segmental pressure recordings, Ankle-brachial index, transcutaneous oxygen measurement and arteriogram.

Doppler ultrasonography works by emitting sound waves to assess blood flow. During the procedure, a hand-held transducer directs high-frequency sound waves into the artery being tested. Sound waves strike the moving Red Blood Cells and change frequency in relation to the velocity of the RBC's. The physician then reviews the graphic results of the waveforms to determine whether an obstruction exists.

Segmental pressure recordings are usually the first test to assess the adequacy of arterial blood flow to the legs. Normally, blood pressure readings taken in the arm and the leg should be the same when the patient is lying down. A lower reading in the leg indicates a possible arterial blockage.

Blood pressure is measured in both arms and legs with the patient lying down. The blood pressure is measured at several different points along the leg. Each reading is accompanied by a waveform tracing of the pulse at the time. The entire procedure takes less than 30 minutes.

Ankle-brachial index (ABI) – ABI is a value derived from blood pressure measurements in the ankle and the brachial area. To perform this test you will need to:

1) Place the patient in a horizontal position so the brachial artery and the dorsal pedis and posterior tibial arteries are at the same level
2) Take brachial blood pressure measurements on both sides. If they differ, the higher of the two systolic pressure is used to calculate the ABI
3) Then wrap the blood pressure cuff around the ankle just above the malleoli. The dorsalis pedis or posterior tibial artery is identified, and the Doppler transducer is held over the artery at the 45-degree angle
4) The blood pressure cuff is inflated until the Doppler signal is no longer heard; then the cuff is slowly deflated. When the Doppler signal returns, the pressure is recorded. This is the ankle systolic pressure.

ABI is calculated by dividing the ankle pressure by the higher of the two brachial systolic pressures. These are interpreted as:

ABI ratio	Interpretation of Risk
> 1.1 (diabetic patients)	Skewed reading due to calcified or non compressible ankle arterial vessels
0.9 – 1.1	Normal arterial perfusion
0.7 – 0.9	Intermittent Claudication possible
0.5 – 0.7	Arterial occlusive disease, claudication
< 0.5	Severe arterial occlusive disease, resting ischemic pain
< 0.2	Risk of gangrene

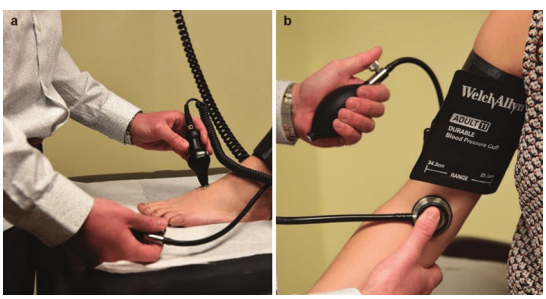


Figure 6-D Obtaining ABI

This test can be performed at the wound care clinic. This test is used to assess the perfusion of the microvasculature system. A TCPO2 is performed by attaching an electrode filled with transducer fluid to the skin and monitoring for measurements. Room temperature is kept constant to ensure an accurate reading. The patient is monitored for approximately 20 minutes as the measurements are taken.

A TCPO2 reading of approximately 40mm Hg is generally regarded as the lowest value in which a wound will heal. A reading of 20 or less is indicative of severe ischemia. An oxygen challenge is also provided during the test with a non-rebreather mask. The levels are then monitored for an increase. A positive oxygen challenge is indicated when there is an increase by 50% over the baseline room air reading. This may indicate that the patient would benefit from hyperbarics.

Arteriogram

This test is done in hospital by a cardiologist. The arteriogram is an invasive procedure that is obtained by inserting a catheter into the arterial system, injecting a radiopaque contrast medium and taking x-rays as the contrast medium is injected. The resulting image shows the lumen of the artery and any defect present. While this test give a good picture of the artery it also carries some risks to the patient such as possible damage to the artery and possible allergy to the contrast medium.

Surgical Intervention

Surgical intervention for arterial ulcers focuses on restoring the arterial flow and the oxygen to the ulcer. Surgical interventions include angioplasty, arterial bypass and stents. The ulcer must also receive good wound care in order to heal.

Wound Care For Arterial Ulcers

Keep dry, gangrenous arterial ulcers dry and protected from pressure. The wound care orthotist can help with the offloading of these ulcers. There are many options for keeping it protected including using large bulky dressings or protective footwear. Remember that new ulcers can form from very little pressure. It is important that any footwear used is closely checked for pressure points.

Carefully monitor the line of demarcation between dead and viable tissues. If any infections develop they should be treated with IV antibiotics.

After a successful revascularization the wound can be treated as any other wound and the wound itself should be kept moist with the surrounding tissues kept dry. Consider using a hydrocolloid or hydrogel dressing. Use a moist dressing in the wound bed and cover with a dry dressing.

Lymphatic Ulcers

What is lymphedema? The lymphatic system is comprised of a protein rich fluid similar to plasma. This fluid is filtered through the lymph nodes, these nodes also add lymphocytes to the fluid. Lymph moves slowly through the lymphatic system.

Lymphedema is swelling that occurs when an obstruction prevents the normal flow of lymph into venous circulation. Injury to the swollen tissue may cause an ulcer to occur. These ulcers usually are found on the arms or legs and are very difficult to heal.

Lymphedema can be congenital or acquired. Acquired lymphedema can be caused by surgery that severs or removes lymph nodes, an example would be a radical mastectomy. It can also be the result of obesity that compresses a vessel or node. Other causes are chronic venous hypertension in which the edema is poorly managed.

Patients with lymphedema may require long-term antibiotic therapy. The treatment for lymphatic ulcers has two goals:

- Reduce edema (leg elevation is very important)
- Prevent complications such as infection

The use of a compression pump is an effective method of reducing edema. It reduces the volume of fluid in the lymphedematous limb. The pressure should be set low on the pump, in the range of 30 to 50 mm Hg. After each compression session, the patient must use compression bandages or another compression garment. Without these the gains from the pump are lost when the patient stands up.

Lymphatic ulcers in the legs are usually found around the ankle area, but can develop at any trauma site. They are shallow and may be oozing, or blistered. The surrounding skin is usually firm, fibrotic and thickened by edema. Cellulitis may also be present. The clinical diagnosis is based on the appearance of the skin.

Wound care for the patient with lymphedema is very much like wound care for the patient with venous ulcers. The only difference is that the patient with lymphedema is much more likely to get an infection. When choosing dressings for patients with lymphedema pick those that can manage large fluid loads while protecting surrounding skin (foams or other absorbent dressings would be a good choice).

Key Points When Treating Vascular Wounds

The ulcer is just part of the problem there is a much deeper problem for the ulcer. You must locate the underlying problem in order for the ulcer to heal. For instance, with venous ulcers, the underlying venous hypertension must be treated and with arterial ulcers, the arterial flow must be restored.

- Vascular disease is pervasive; look for other problems in other areas of the body
- The axiom of keeping dry tissue dry and moist tissue moist applies to vascular wounds, with the one exception that an arterial wound must be kept dry until it has been revascularized, then the axiom applies as well
- Avoid using tape as much as possible on the patient's skin. Skin affected by vascular disease is fragile and new ulcers form easily.