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# Clinical Assessment of Peripheral Arterial Disease of the Lower Limbs

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## OVERVIEW

Arterial perfusion of the lower limbs is commonly encountered in general and specialist practice and has both acute and chronic presentations. A systematic assessment of patients with this condition is essential to prevent limb or tissue loss.<sup>1,2</sup>

## INDICATIONS

Arterial disease in the lower limbs is often caused by atherosclerosis, thrombosis, or embolism. In addition, traumatic damage to the arterial wall, compression of the arterial lumen (e.g., popliteal entrapment syndrome), or changes in the arterial wall (e.g., thromboangiitis obliterans) may occur. Patients with peripheral arterial disease may present with intermittent claudication, muscle pain at rest, arterial ulceration, or gangrene.<sup>1-7</sup> In patients with ulcers or in those who are about to undergo surgery of a lower limb, the patency of the arterial tree must be assessed to determine the likelihood of healing.

## CONTRAINDICATIONS

Examination of the legs and feet may have to be delayed in patients with life-threatening damage to the airway, breathing difficulties, or cardiovascular problems. However, since arterial injuries of the lower limbs may be the cause of hemodynamic instability owing to hemorrhage, sepsis, or metabolic acidosis, a vascular examination of the lower limbs should be performed as part of the cardiovascular evaluation of an unwell patient.

## ANATOMY

The aorta bifurcates at the fourth lumbar vertebra, which in most patients is at the level of the umbilicus. At the point of bifurcation, the aorta forms the right and left common iliac arteries, which eventually form the external iliac arteries. Each leg is supplied by an external iliac artery, which travels beneath the inguinal ligament to form the common femoral artery.

The common femoral artery divides to form the superficial femoral artery and the profunda femoris artery in the upper thigh. The superficial femoral artery travels through the anteromedial thigh in the subsartorial canal, with no branching, and transports blood to the leg below the knee. At the level of the knee, the superficial femoral artery passes through the adductor hiatus and becomes the popliteal artery.

Below the knee, the popliteal artery branches into the anterior tibial artery and the tibioperoneal trunk. The anterior tibial artery travels to the dorsum of the foot, where it can be palpated as the dorsalis pedis pulse. The tibioperoneal trunk divides into the posterior tibial artery and the peroneal artery. The posterior tibial artery travels posterior to the medial malleolus, where it can be palpated as the posterior tibial pulse.

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*N Engl J Med* 2018;378:e24.

DOI: 10.1056/NEJMvcm1406358

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**PREPARATION**

A Doppler probe and a blood pressure cuff should be available for the examination.<sup>7</sup> Introduce yourself to the patient and obtain consent to perform the examination. Ask how the patient is feeling and whether there is any pain or tenderness. The patient should have been instructed to remove clothing such that the lower limbs are completely exposed. You should remove any bandages or wraps. Place the patient in the supine position, either lying flat or lying with the head of the bed at a 45-degree angle, depending on which option is the most comfortable.

**EXAMINATION***General Examination*

If you are examining a hospitalized patient, observe the bedside environment for indicators of the patient's functional status or for evidence of risk factors for vascular disease. Look at the patient's hands for tobacco stains or cyanosis, and assess the temperature of the hands. Check the patient's radial or carotid pulse to rule out atrial fibrillation. Obtain blood pressure measurements in both arms.<sup>8</sup>

*Inspection*

If the patient has sustained trauma, identify any sources of external bleeding. In general, inspection of the lower limbs focuses on changes in the skin (including color, scars, and ulcers), swelling or wasting of the soft tissue, and deformity of the bones.

*Skin*

Examine the abdomen for scars resulting from previous surgery to the aorta or iliac vessels. Look for scars on the legs resulting from previous procedures. Carefully examine the groin by stretching the skin folds open. Assess the medial aspect of the legs for scars caused by lower-limb bypass surgery,<sup>8</sup> such as a femoral-popliteal or femoral-distal bypass procedure.

Always assess the color of the skin. Look for pallor or cyanosis, which may indicate hypoperfusion. In contrast, erythema may be caused by an underlying infection, such as cellulitis or an abscess. Purulent discharge through a wound or sinus is suggestive of a deep, infected collection. Also identify areas of darker skin, which may represent dry or wet gangrene. Look for thin skin, hair loss, and hypertrophic changes in the toenails, which may indicate chronic ischemia.

An ulcer is a break in the epithelial surface of the skin or mucosa. Identify any leg ulcers, making sure to inspect the heels and the skin between the toes.<sup>6</sup> Note the location, size, edges, and base of any ulcers that are present (Table 1).

**Table 1. The A–F System for the Assessment of Ulcers.**

System	Examination
Area	Describe the anatomical location, size, and surface features of the ulcer.
Base	Inspect the content of the ulcer, noting the presence of granulation tissue, exposed tendons, and bones or blood vessels.
Contour	Assess the edge and shape of the ulcer. Note whether it has a sloping, undermined, punched-out, everted, or rolled edge. Also note whether the ulcer has a regular or irregular border.
Denervation	Check sensation of the skin around the ulcer; insensate ulcers are associated with diabetes or neuropathy.
Erythema	Diagnose infections associated with ulceration, such as cellulitis or an abscess.
Fatal errors	Note any “fatal errors,” which include burns, Marjolin's ulcer (squamous-cell carcinoma), and dermatologic conditions.

### Soft Tissue

Inspect the legs for swelling or wasting of the soft tissues. Swelling may be caused by infection, abscess formation, lymphedema, or pathologic venous conditions, such as deep-vein thrombosis. Swelling may also be caused by other conditions, such as nephrotic syndrome or heart failure, but in these cases, edema is more likely to occur in both legs. A unilaterally swollen leg should be viewed as having an underlying pathologic vascular condition unless proved otherwise.

The patient should also be examined for a wasting condition. Wasting can be a sign of ischemia, neurologic injuries, or long-term inactivity resulting from pain or a generally poor functional state.

### Bones

Identify any amputations of the toes, feet, or legs (above or below the knee). Lower-limb amputations can be a marker of end-stage arterial disease or previous trauma. Also examine the limbs for the presence of deformities or fractures that may compress and occlude arteries and thus lead to ischemia.

## PALPATION

### *Skin and Soft Tissues*

Before you begin the palpation of any tissue, ask the patient whether there are any painful or tender areas in the groin, legs, or feet. Then proceed with the steps listed below.

Feel the patient's skin with the back of your hand to assess the temperature. Use your fingers and palms to palpate for tenderness. Gently palpate the thigh and calf muscles and then the foot, ankle, and knee joints. Inquire about pain, and as you palpate different areas, note the patient's facial expression to identify signs of discomfort. Palpate the tissues in the proximity of scars to identify any subcutaneous prosthetic grafts, such as bypass grafts.

In patients with acute ischemia or trauma, be aware that compartment syndrome may be developing. Compartment syndrome can occur even in the presence of palpable pulses.

### *Pulses*

Begin by palpating the aorta. Use two hands to palpate the aorta above the umbilicus and slightly to the left of the midline (Fig. 1).

Palpate the common femoral pulse just below the groin crease, at the level of the midinguinal point. The midinguinal point is the middle of an imaginary line running from the anterior superior iliac spine to the pubic symphysis (Fig. 2).

With the patient's knee slightly flexed and relaxed in your hands, palpate the popliteal pulse, which is not always readily palpable. It is easiest to feel this pulse by placing the index and middle fingers of both hands deep in the popliteal fossa while your thumbs rest on the tibial tuberosity (Fig. 3).

You can usually identify the dorsalis pedis pulse by asking the patient to lift the great toe upward. This pulse will be found lateral to the extensor hallucis longus tendon, which becomes visible when the great toe is in dorsiflexion (Fig. 4).

Palpate the posterior tibial pulse behind the medial malleolus. This pulse is located halfway between the malleolus and the Achilles' tendon (Fig. 5).

Pulse strength should also be documented. If a pulse is absent, it should be noted as 0; if diminished, as 1+; if normal, as 2+; and if bounding, as 3+.<sup>9</sup>

### *Capillary Refill Time*

Assess capillary refill time by gently pressing on the pulp of the toe or the nail bed for 3 seconds and counting the time needed for reperfusion to occur. A refill time that is longer than 3 seconds is abnormal.



**Figure 1.** Palpation of the Aorta.



**Figure 2.** Palpation of the Common Femoral Pulse.



**Figure 3.** Palpation of the Popliteal Pulse.



**Figure 4.** Palpation of the Dorsalis Pedis Pulse.



**Figure 5.** Palpation of the Posterior Tibial Pulse.

*Bones*

Palpate the bones of the legs and feet, checking for tenderness, step deformity, and abnormal mobility. Deformities or fractures may compress and occlude arteries and lead to ischemia.

**ASSESSMENT OF FUNCTION**

Assess sensation and movement and note signs of neural impingement. Ischemia with acute incipient sensory or motor loss is a vascular emergency that requires immediate intervention.<sup>1</sup> Evaluate gross sensation by touching areas of the lower limb that correspond to specific dermatomes, as shown in the video. Assess sensation in each leg, and compare the findings. Plantarflexion and dorsiflexion of the foot should also be assessed, as should flexion and extension of the knee and hip. To rule out sciatica as a cause of lower-limb pain, instruct the patient to perform a straight-leg raise.

**SPECIAL TESTS***Buerger's Test*

The test of leg elevation known as Buerger's test is used to detect poor blood flow in a critically ischemic limb. Ask the patient to lift one leg off the bed. Support the straight leg at a 45-degree angle from the bed and observe it for the development of pallor. In a patient with normal arterial anatomy or only moderate atherosclerosis, the color in the leg will not change. If leg elevation leads to pallor, place the leg in a dependent position and, as reperfusion occurs, observe the leg for reactive erythema or dependent rubor,<sup>6</sup> each of which is caused by vasodilation in response to a period of relative ischemia.

*Doppler Ultrasonography*

The flow of blood in the common femoral, popliteal, dorsalis pedis, and posterior tibial arteries and in any prosthetic or venous bypass grafts can be assessed with the use of Doppler ultrasonography.<sup>7</sup> Healthy arteries produce a triphasic flow signal. As the severity of arterial stenosis increases, the waveform becomes biphasic and then monophasic and is eventually absent.

*Ankle–Brachial Index*

The ankle–brachial index compares the blood pressure in the arm with the blood pressure in the leg.<sup>10</sup> Please see the video on this topic (available at NEJM.org) for a complete description of this technique.<sup>11</sup>

**COMPLICATIONS**

Make sure that in focusing on the assessment of arterial blood flow you do not overlook other potentially life-threatening or limb-threatening conditions. Such conditions involving the lower limbs include deep-vein thrombosis, phlegmasia cerulea dolens, necrotizing fasciitis, compartment syndrome, malignant ulcers, spinal complications, and lymphedema.

**SUMMARY**

When you perform a vascular arterial assessment of the legs, bear in mind the underlying arterial anatomy and its effect on perfusion of the skin, soft tissues, and bones. If the patient has signs of peripheral arterial disease, obtain a rapid consultation with a vascular specialist. If there are signs or symptoms of acute limb ischemia, send the patient to the emergency department immediately for additional assessment and imaging of the arterial anatomy. This additional imaging may include duplex ultrasonography, computed tomography, and magnetic resonance angiography.<sup>6</sup>

No potential conflict of interest relevant to this article was reported.  
Disclosure forms provided by the authors are available with the full text of this article at NEJM.org.

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