

Peripheral Vascular Disease (The Lower Extremity)

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Radiology

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Objectives

1. Explain the difference between claudication and ischemia.
2. Describe the basic anatomy of the arterial tree as it branches off the aortic arch and the abdominal aorta.
3. Compare and contrast the risks and benefits of angiography and identify in which patients the procedure is contraindicated.
4. Describe the types of disorders encountered in the lower extremities of patients who demonstrate peripheral vascular disease.

Article

PERIPHERAL VASCULAR DISEASE

(The Lower Extremity)

Author: Arnold S. Rappoport M.D.

Objectives: Upon the completion of this CME article, the reader will be able to:

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3. Compare and contrast the risks and benefits of angiography and identify in which patients the procedure is contraindicated.
4. Describe the types of disorders encountered in the lower extremities of patients who demonstrate peripheral vascular disease.

Introduction:

The definition of peripheral vascular disease is insufficient arterial blood flow to the extremities. The most common cause for peripheral vascular disease is atherosclerosis, which is primarily found in arteries (also called arteriosclerosis). Inflammatory diseases of arteries may also cause peripheral vascular disease, but these are rare, the most noteworthy one being called Buerger's disease (named after Dr. Buerger – also called thromboangiitis obliterans).

The more common risk factors for the development of peripheral vascular disease are diabetes mellitus, hypertension and cigarette smoking as well as a family history of hyperlipidemia. There are two broad categories in which patients with peripheral vascular disease present:

Claudication is where pain is experienced while walking and stops when the patient is at rest. The pain occurs in a muscle group where the supply of blood is not enough to meet the metabolic demands of exercise or activity.

Ischemia is the more severe form, which manifests as pain while at rest in bed. The decrease in blood supply is so significant that it results in poor nutrition to the skin of the feet and legs resulting in coldness, discoloration, skin breakdown, ulceration and ultimately gangrene.

Relevant Anatomy:

For the lower extremities, the abdominal aorta divides in the pelvis into right and left common iliac arteries, which in turn divide

into an external and internal iliac artery. The internal iliac artery supplies the pelvis, whereas the external iliac artery supplies the lower extremity (figures 1 & 2). At the level of the inguinal ligament, the external iliac artery is named the common femoral artery and a short distance beyond that it bifurcates into a deep and superficial femoral artery. The superficial femoral artery is the main vessel responsible for lower extremity circulation (figure 3). It becomes the popliteal artery just above the knee, passes through the knee, and then bifurcates into three vessels. Two of these, the anterior and posterior tibial vessels, cross the ankle and supply the foot. The third branch is called the peroneal artery and it terminates just above the ankle.

For the upper extremities, the first major arterial branch off the aortic arch is the brachiocephalic trunk, which then branches into the right common carotid artery and the right subclavian artery. The next two major branches off the aortic arch are the left common carotid artery and the left subclavian artery. The subclavian arteries become the axillary arteries as they pass through the shoulder and axilla and then they become the brachial arteries in the upper arm. The brachial artery then bifurcates into the ulnar artery and the radial artery after it crosses the elbow. The ulnar and radial arteries supply the lower arm and hand.

Clinical Examination:

The majority of patients with peripheral vascular disease have complaints that involve the lower extremities. The basic clinical examination for these patients is to obtain a history that looks for risk factors (as described above) and establishing the claudication distance, that is, the distance the patient can walk before experiencing muscle cramps severe enough to stop walking.

The femoral pulse in the groin, the popliteal pulse behind the knee and the two pedal pulses (dorsalis pedis artery and posterior tibial artery) are palpated. Any absence or diminution of a pulse should be noted.

Basic non-invasive testing involves recording the blood pressure at the ankle utilizing a blood pressure cuff applied around the calf and measuring the pressure of the pedal arteries. These ankle pressures are then compared with an arm pressure. The ratio of ankle to arm pressure is an important value called the Ankle-Brachial Index. A normal index is 1 or just above 1. Typically, claudication occurs with ankle-brachial indices between 0.5 and 0.8. Lower extremity pain that occurs at rest is typically less than 0.3 and gangrene occurs at indices less than 0.2. More extensive non-invasive studies can be performed in a non-invasive vascular lab, which involves recording the pulse waveform of the vasculature in the lower extremity and also determining oxygen tensions in the subcutaneous tissues of the foot.

Angiography:

Angiography is the definitive test for demonstrating the arterial anatomy. For a lower extremity evaluation, the examination must include the abdominal aorta and the entire lower extremity to the foot. It is fundamentally important that the findings of the angiogram correlate with the clinical history and examination as well as the non-invasive vascular studies. Before performing angiography, the patient's renal function must be checked by obtaining a BUN and creatinine level as well as making sure that the patient is not anticoagulated to therapeutic levels or is at risk of bleeding. Renal failure and impairment of blood clotting mechanisms are contraindications to performing angiography.

Angiography is performed under aseptic conditions. Access to the patient's vascular system is through the femoral artery when these are patent as determined by the presence of a palpable pulse. If these are absent, angiography is then performed through the left axillary artery. Access to the arterial system is typically made through the femoral artery of the less symptomatic or asymptomatic lower extremity. This area is washed with Betadine and draped with sterile cloth. A local anesthetic is injected over the common femoral artery. The technique used for catheterization (known as the Seldinger technique) is performed by inserting a needle into the femoral artery. A safety guidewire is then passed through the needle, followed by advancing an angiographic catheter (which is 5 French in diameter) over the guidewire and positioning it in the aorta for the abdominal aortogram. The first injection of contrast material occurs above the level of the renal arteries followed by an injection above the aortic bifurcation for examination of the lower extremities. The catheter may be placed in a more selective position in the iliac or femoral artery if more detailed films are needed. When the angiogram is completed, the catheter is removed, manual compression is applied to the groin to insure that bleeding stops, and then the patient must rest with a straight leg for an additional four hours to insure a satisfactory seal of the puncture site before being able to ambulate.

An iodinated contrast agent is utilized and either a non-ionic or low osmolar contrast is injected. The volume of contrast agent injected varies amongst different angiographers but typically a total of approximately 100-150 cc is used for a complete examination.

Filming:

Current modern equipment in most institutions consists of digital subtraction angiography. In older units, cut-film angiogram films are obtained. In any event, it is important that the entire length of the vessel under examination be evaluated (filmed). If there is an occlusion, the point at which flow is reconstituted below the occlusion must also be filmed.

Types of Lesions Encountered:

Restriction of flow may be due to a stenosis (narrowing of the vessel). The degree of stenosis is the ratio between the diameter of the narrowest portion of the narrowed area compared with the normal diameter of this vessel. This ratio is expressed as a percentage. Restriction may also be due to a complete occlusion. With significant stenoses and occlusions, collaterals will form whereby vessels above the area of narrowing or occlusion will enlarge, communicate with other vessels, which in turn will carry blood to the vessel below, bypassing the occlusion (figure 4). In most instances, this collateral bypass mechanism is inadequate to supply the needs of the limb downstream. When claudication is the presenting symptom, there is enough blood flow to sustain viability of the tissues at rest, but not enough to meet the demands of the muscles encountering exercise or activity. When the collateral vessels are inadequate to supply enough blood to nourish the tissues at rest, the various stages of ischemia will develop (coldness, discoloration, skin breakdown, ulceration) ultimately leading to gangrene.

Stenosis or occlusion of the iliac vessels (pelvic vessels) is referred to as inflow disease. When the femoral vessels are affected, this is referred to as outflow disease and when the vessels below the knee are involved, it is referred to as distal disease. Diabetics commonly have distal disease since the smaller arteries are involved. Patients who have inflow disease typically complain of claudication in the buttocks, whereas those with outflow disease most often complain of claudication in the calves.

It is incumbent upon the angiographer to make sure that the angiographic findings correlate with the clinical presentation. In some cases, the usual AP projection of the abdomen, pelvis, and lower extremity runoff may not be enough for a complete evaluation. Therefore, in some circumstances, oblique or lateral views will be necessary to demonstrate lesions accurately.

Complications of Angiography:

The more common complications related to angiography include bleeding, reactions to the contrast material, and problems related to the insertion of the guidewire or angiogram catheter. Bleeding is most often seen in the groin and sometimes a hematoma can form. Complications related to the contrast agent primarily include allergic reactions and occasionally kidney dysfunction that can lead to renal failure.

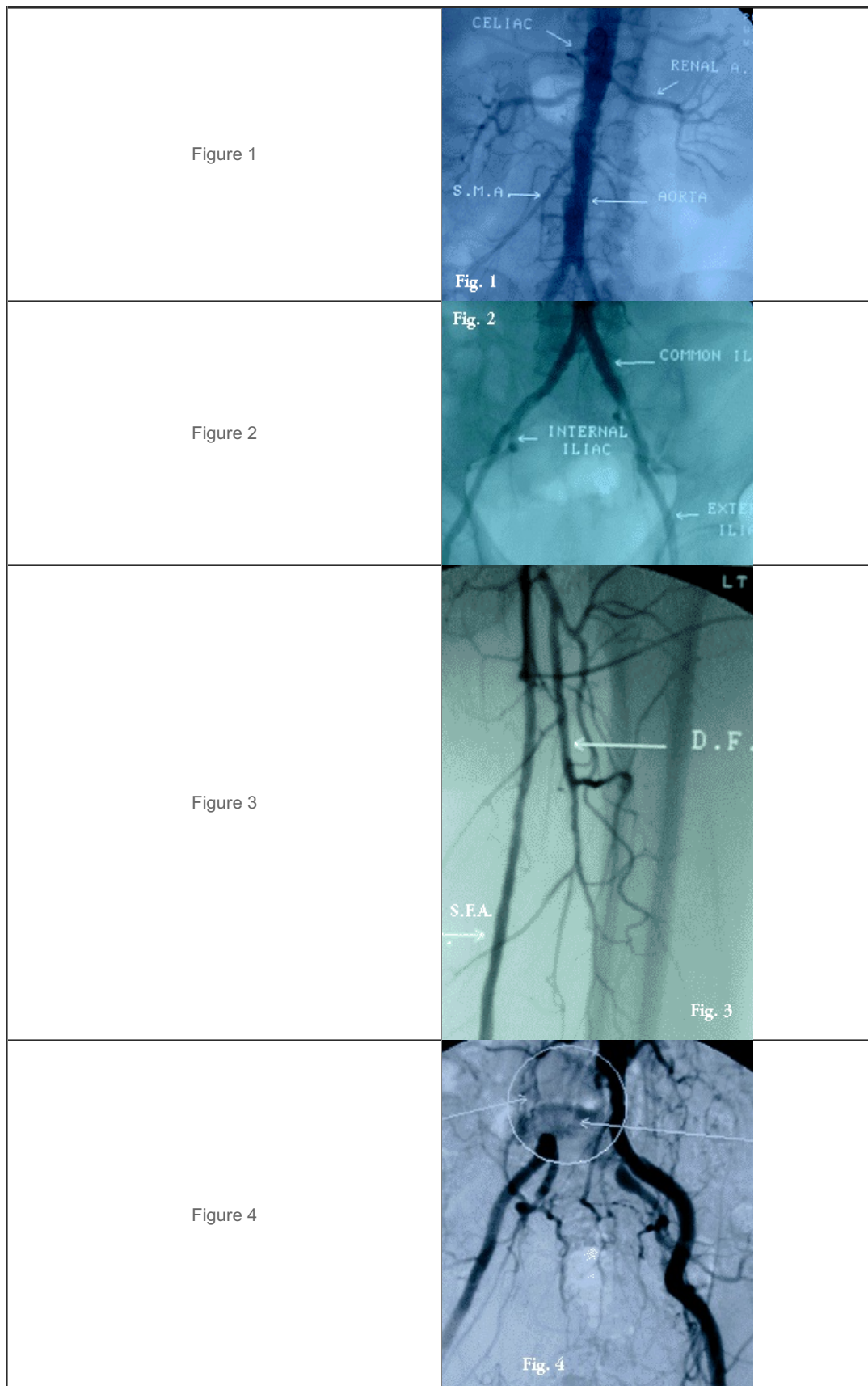
Problems related to the insertion of the guidewire and or catheter involve intimal dissection of the inside wall of the artery. When this occurs, the catheter tip or guidewire peels off an atheromatous plaque that is located on the inside wall of the blood vessel. This might result in complete occlusion of the vessel and on rare occasions embolic phenomenon that could occlude a vessel downstream.

Buerger's Disease:

Buerger's disease (also called thromboangiitis obliterans) is an inflammatory vascular disorder that primarily affects small and medium sized arteries of both the upper and lower extremities. It most frequently develops in men under the age of 40 with prevalence in the Asian and Eastern European populations. The disorder results in the infiltration of inflammatory cells (white cells and mononuclear cells) into the wall of the blood vessels. Over time, this inflammatory response is replaced by fibrosis and vessel occlusion.

Figures:

1. A normal flush aortogram revealing the major arterial branches off the abdominal aorta.
2. Aortogram revealing the major arterial branches in the pelvis – the common iliac and the internal and external iliac vessels.
3. Arteriogram of the common femoral artery branching into the deep femoral and superficial femoral arteries.
4. A patient with right leg claudication. An aortogram reveals occlusion of the right common iliac artery with collateral vessels reconstituting flow below the obstruction.



References or Suggested Reading:

1. Handbook of Interventional Radiological Procedures: Kandarpa and Aruny, Second Edition, Little Brown & Company, 1996, p. 3-23, 279-287, and 313-356.
2. Damuth HD, Jr., Daimond AB, Rappoport AS, Renner JW: Angioplasty of Subclavian Artery Stenosis Proximal to the vertebral Origin. AJNR Vol. 4, pp. 1239-1242.

About the Author(s)

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Dr. Rappoport is a Fellow of the American Board of Radiology and is a Fellow of the Royal College of Radiology. He is also a member of the Society for Cardiovascular Interventional Radiology and the Western Angiographic Society. He has published numerous articles in peer-review journals and has presented lectures regarding Interventional Radiology across the country and internationally.



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