Revascularization for Peripheral Arterial Disease among Older Adults: Referral, Management, and Prognosis

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Peripheral arterial disease (PAD) is a common disorder among older adults. Recognition of the signs and symptoms and appropriate referral of patients to a vascular surgeon can improve functional outcomes and limb salvage. Behavioural, medical, and percutaneous endovascular or open surgical therapies may all be used, depending upon the severity of symptoms and likelihood of limb loss. Cardiovascular comorbidities are common with PAD, and appropriate treatment to minimize cardiovascular mortality is important.

Key words: *peripheral arterial disease, claudication, critical limb ischemia, endovascular treatment, lower extremity bypass*

Introduction

Peripheral arterial disease (PAD) is a disorder involving occlusive vascular conditions of the upper and lower extremity vessels, aorta, renal vessels, or mesenteric vessels. This article focuses upon the management of PAD specific to the lower extremities; however, it is important to recognize that this occurs within a field of arterial occlusive disease and often is associated with other cardiovascular conditions. Recognition of PAD during early stages is important, especially among the older adult population, in which the disorder is far more common, as interventions ranging from lifestyle modifications to surgical vascular bypass can be initiated to maintain perfusion to the lower extremities.

Epidemiology and Pathophysiology

Peripheral arterial disease is an atherosclerotic condition with obstructive plaques located anywhere from the aorta and iliac vessels to the distal pedal vessels.[1,2] Other disease processes have been implicated as less common etiologies and can be divided into degenerative disorders causing impaired vessel wall integrity and coagulopathic states causing altered hemodynamic flow. Examples include collagen vascular diseases, cystic medial degeneration, fibromuscular dysplasia, vasculitides, radiation arteritis, thromboangiitis obliterans (Buerger's disease), and thromboembolic diseases.[1–3]

Intermittent claudication, a symptom indicative of PAD, is estimated to exist in >10% of persons over 70 years of age and between 2 and 7% of those younger than 70. The prevalence increases with age and male gender.[2–8] Many previous studies have used the symptom of claudication as a marker for PAD, while others have focused on objective measurements that give a more reliable estimate of disease presence. Large screening studies of at-risk populations have found a prevalence of 19–29% when PAD was defined as an ankle brachial index (ABI) <0.9.[8,9]

Risk factors associated with PAD are those associated with atherosclerotic disorders in general, such as age, male gender, diabetes mellitus, tobacco smoking, dyslipidemia, hypertension, family history, Black race, and hyperhomocysteinemia.[1–4,7–10] Studies have revealed as much as a twofold increase associated with male gender, hypertension, dyslipidemia, Black race, and hyperhomocysteinemia. An even stronger relationship exists for diabetes and tobacco use. Age is related in an incremental fashion, with the risk increasing each decade.[2,7,11]

Clinical Presentation and Diagnosis

Symptoms and Natural History

Symptoms vary as a spectrum of the disease condition and may include asymptomatic, atypical leg pain, classic intermittent claudication, rest pain, and tissue loss.[2] Claudication is generally described as aching or cramping pain in a muscle group that occurs with exertion and is relieved within 10 minutes by rest.[12] The pain is highly reproducible with activity. Critical limb ischemia (CLI) is a manifestation of severe PAD and is defined as persistent rest pain or tissue loss in the form of nonhealing ulcerations or gangrene. Rest pain frequently occurs in the foot and may awaken the individual from sleep. The pain is typically relieved by dependency, and people often describe their nightly routine of dangling a leg over the side of the bed to relieve discomfort.[13]

The level of arterial disease is frequently associated with the location of symptoms and affects diagnostic and therapeutic management. Buttock and hip claudication is typically reflective of

aortoiliac disease, thigh claudication of aortoiliac or common femoral disease, calf pain of superficial femoral or popliteal disease, and occasional foot claudication of infrapopliteal disease. Aortoiliac disease may also be associated with male impotence (Leriche syndrome).[1,3]

The natural history of PAD is not always progressive, with only one of four persons with claudication developing worsening symptoms and 5% requiring surgical management.[2,4] Progression of disease and the need for intervention or amputation are greatly increased among persons with diabetes and those who smoke.[3,4] Individuals with PAD also have a significantly increased risk of cardiovascular events. Mortality among individuals with claudication is two and a half times higher than among an age-matched population, primarily attributed to cardiovascular causes. All-cause mortality is 30% at 5 years, 50% at 10 years, and 70% at 15 years. Critical limb ischemia represents an advanced stage of PAD and occurs in 1–3% of patients. In the case of CLI, outcomes are more ominous, with 25% requiring major amputation and another 25% experiencing a fatal event at 1 year.[2,4]

History and Physical Examination

A complete history including questions regarding claudication, rest pain, walking impairment, nonhealing wounds, and family history is recommended for all older patients or patients with risk factors. Physical examination should involve a full vascular assessment including blood pressure and pulse symmetry, bruit examination (carotid, abdominal, femoral), palpation for an aortic aneurysm, palpation of all peripheral pulses with intensity assessment, and lower extremity skin inspection for colour, warmth, capillary refill, hair loss, trophic changes of skin or nails, and ulcerations.[2] If PAD is suspected, referral to a vascular surgeon for further evaluation and noninvasive laboratory testing is indicated (Table 1).

Table 1: Indications for Referral to a Vascular Surgeon and Noninvasive Arterial Testing

Absent pedal pulses and:
Nonhealing ulcerations or gangrene
Claudication—reproducible exertional calf pain relieved within 10 minutes of rest
Rest pain—pain in the foot at rest, typically relieved with leg dependency

Diagnostic Arterial Studies

There are a number of noninvasive arterial studies that can help to delineate the severity and location of disease that should be performed when PAD is suspected. These include ABI, Doppler ultrasonography, pulse volume recording, and transcutaneous oxygen tension measurement (Table 2). Exertional studies that use treadmill walking may be necessary to fully reveal disease among individuals with more mild exercise manifestations.[14]

The ABI involves measuring the systolic blood pressure at the ankle and comparing it with a reference systolic blood pressure in the arm. A normal ABI is >1.0 among the nondiabetic population. Correlations with symptoms and angiographic findings have been shown and, while not absolute, represent reasonable values for diagnosis. An ABI <0.9 is generally used for the diagnosis of PAD, whereas an ABI <0.6 correlates with the more severe symptom of rest pain, and <0.3 with significant limb threat.[14,15] Segmental pressures measured along the length of the leg and toes are more specific for identifying vascular segments involved in disease. Medial arterial calcification, commonly associated with diabetes and renal failure, may cause false elevation of ankle pressure measurements and is therefore less reliable in these populations. Digital arteries are less frequently affected by medial arterial calcification; therefore, toe pressures are used unless multiple toe amputations

Table 2: Noninvasive Arterial Studies

	Pros	Cons
Ankle brachial index	Simple screening tool	Unreliable in diabetes or end-stage renal disease
Toe pressure index	More reliable in diabetics Gives information regarding likelihood of wound healing	Requires small cuff Difficult if toe amputations or open wounds
Doppler ultrasonography	Lesion localization possible	Operator dependent
Pulse volume recording	Simple screening tool	Nonquantitative Affected by temperature, heart failure, vasoactive medications
Transcutaneous oxygen tension	Gives information regarding likelihood of wound healing	Operator dependent, affected by temperature

Table 3: Exercise Therapy for Intermittent Claudication

Supervised exercise should be made available as part of the initial treatment for all individuals with peripheral arterial disease.

The most effective programs employ treadmill or track walking that is of sufficient intensity to bring on claudication, followed by rest, over the course of a 30 to 60 minute session. Exercise sessions are typically daily for 3 months.

Source: Adapted from Norgren, *et al.*, 2007.[2]

prohibit this.[14,16] Toe pressure measurements may also give helpful information regarding the likelihood of healing a wound without revascularization; however, the technology may not be available at every institution.

Doppler ultrasonography may be used for audible pulse interpretation, waveform analysis, and duplex ultrasonography–derived velocity measurements between vessel segments to identify specific stenotic lesions. Pulse volume recording tests use plethysmography to assess the severity and level of disease by a comparison of pulse amplitude and contour. This test has a high sensitivity combined with segmental pressure measurements. Transcutaneous oxygen tension is a marker of metabolic assessment of tissue perfusion. While not dependent upon vessel calcification, it is highly dependent upon the operator, ambient temperature, and skin temperature, so results are not always reliable.[14]

Computed tomographic angiography (CTA) and magnetic resonance angiography are other noninvasive testing modalities increasingly being used and provide the benefit of three-dimensional images. However, CTA carries a risk of contrast nephropathy; therefore, it should be used sparingly among patients with renal impairment.

Diagnostic angiography is the gold standard for the assessment of arterial blood flow and is generally performed in a preoperative workup when revascularization is indicated. Additionally, if symptoms and anatomical findings warrant, therapeutic intervention may be attempted concurrently.

Treatment Options

There is no doubt that rest pain or tissue loss in the form of nonhealing ulcerations or gangrene warrants revascularization for the preservation of the limb. As mentioned previously, 25% of individuals with CLI die within 1 year and another 25% undergo amputation. Of the remaining patients, few improve without invasive intervention.[4]

In contrast, claudication is not likely to immediately threaten the limb, and a variety of treatment options may be appropriate. Severely disabling or lifestyle-limiting claudication is generally an indication for revascularization consideration. Individuals who are either asymptomatic or have mild claudication symptoms are generally best suited by behavioural interventions and pharmacotherapy along with regular follow-up. These individuals make up the majority of patients with claudication in a primary care setting. If patients fail, consideration for intervention is appropriate. Patients must also be able to benefit from an improvement in their claudication without other factors that would limit ambulation.[2]

Behavioural and Medical Interventions

Behavioural interventions include smoking cessation and an exercise regimen. An exercise program most often involves walking to the point of symptoms and then continuing for as long as possible. Each attempt should extend for a longer period of time (Table 3). Supervised programs have been found to be most effective.

Medical treatments include cilostazol, antiplatelet agents, lipid-lowering medications, and blood pressure control agents. Counselling on proper foot care is also critical to prevent ulcerations and infection among individuals with diabetes.[1,2,17,18]

Surgical Interventions

Surgical treatment may be performed via a percutaneous endovascular or open surgical approach. Consideration is given to the level of disease (aortoiliac, femoropopliteal, infrapopliteal), lesion severity (stenosis or occlusion, single or multiple), and patient factors (ability to undergo general anesthesia, ambulatory status, presence of vein conduit and/or bypass target vessel). The TransAtlantic Inter-Society Consensus (TASC) defined a spectrum of stenoses and/or occlusions by angiography with accompanying recommendations for management (Table 4). In general, endovascular treatment is preferred for focal stenoses, whereas bypass is preferred for longer, more complex lesions.[2] Patient comorbidities may favour one therapy over another. Among the older adult population, extensive comorbid disease is common; therefore, endovascular intervention is more frequently attempted to avoid major surgery. There are very few reports of tarsal or plantar vessel angioplasty or bypass, and outcomes are variable; however, attempts by experienced surgeons are reasonable for the outcome of tissue healing if appropriate imaging modalities show a potential target vessel.[19]

Table 4: Treatment of Lower Extremity Lesions

TASC A and D lesions: Endovascular therapy is the treatment of choice for type A lesions, and surgery is the treatment of choice for type D lesions.

TASC B and C lesions: Endovascular treatment is the preferred treatment for type B lesions, and surgery is the preferred treatment for good-risk patients with type C lesions.

The patient's comorbidities, fully informed patient preference, and the local operator's long-term success rates must be considered when making treatment recommendations for type B and type C lesions.

Source: Adapted from Norgren et al., 2007.[2]

Endovascular intervention has the benefits of being less invasive, having no requirement of general anesthesia, involving a minimal hospital stay, and generally resulting in a more rapid postoperative rehabilitation. Downsides include the need to lie flat during and after the procedure and the use of intravenous contrast agents. Endovascular options include angioplasty, stent placement, atherectomy, thrombolysis, and mechanical thrombectomy. Generally, angioplasty is attempted as the primary modality, with stent placement commonly used in the iliac vessels or in cases of residual stenosis after angioplasty.

Open surgical options include endarterectomy and vascular bypass. Requirements for bypass include a viable target vessel, a vein conduit, and the patient's ability to undergo general, epidural, or regional anesthesia. Autologous vein conduit is generally preferred for infrainguinal bypass, although a synthetic graft may be used if no adequate vein is present. Patency rates of synthetic grafts to below-the-knee targets are inferior to those with vein grafts; generally, synthetic grafts are not routinely used.[2,20]

Outcomes

Operations performed for claudication, whether endovascular or open, have an excellent patency rate, with improvement in symptoms in the majority.[21,22] Operations performed for CLI generally represent more advanced or multilevel disease; thus, prognosis is worse.[23,24] The goal of surgery in CLI is to prevent amputation, and with appropriate management and reintervention when necessary, acceptable limb salvage rates may be obtained with both open and endovascular management. In a study of over 1,000 pedal bypasses performed for CLI, the 5-year primary patency was 57%; however, limb salvage was over 75%.[25] Similarly, a series of infrapopliteal angioplasties revealed a primary patency of only 35% at 2 years but a limb salvage of 85% at 3 years.[26] Other reports of more proximal interventions for CLI have similarly high limb salvage rates.[24,27]

Key Points

- Symptoms that should prompt referral to a vascular surgeon include (1) absent pedal pulses with nonhealing ulcerations or gangrene, or with pain in the foot occurring while lying flat and relieved with dependency of the extremity, and (2) leg pain in a major muscle group occurring with exertion and relieved with rest.
- Mild claudication may often improve with smoking cessation, an exercise regimen, and pharmacotherapy.
- Failure of conservative therapy for mild claudication or presentation with disabling claudication may be an indication for revascularization.
- Critical limb ischemia is an indication for revascularization for the goal of limb salvage.
- Major morbidity and mortality from PAD are from cardiovascular causes irrespective of revascularization.

Vascular surgery is considered a major operation, and preoperative cardiac risk stratification is necessary, especially given the likelihood of concurrent cardiovascular disease. In one recent publication citing outcomes after vascular surgery, mortality was 2.9% after elective lower extremity bypass and 0.4% after endovascular intervention.[28] Outcomes from a national population study cited a mortality of 2.4% in nearly 40,000 open and endovascular interventions for claudication and CLI (0.5% for claudication versus 3.0% for CLI).[29] Advanced age (>75 years), coronary artery disease, and dialysis-dependent renal failure have been associated with an increased mortality and likelihood of myocardial infarction or stroke.[30]

Postoperative Follow-Up

Pharmacotherapy in the form of lipid-lowering and antiplatelet agents is generally maintained postoperatively for the lifetime of the patient.[31,32] After many endovascular interventions and some bypass procedures, dual antiplatelet therapy (acetylsalicylic acid plus clopidogrel) is used to decrease acute thrombosis or graft failure. Regular follow-up with vascular examinations and assessment for recurrent symptoms is mandatory following revascularization. Wound care and treatment of infection is important if tissue loss exists. Periodic surveillance monitoring with noninvasive arterial studies is also practised. This is generally carried out with more frequent vascular laboratory assessments performed early in the postoperative period and extending follow-up to semiannual or annual studies as more time elapses. If symptoms recur, prompt reassessment is critical for the diagnosis of the status change's etiology and timely treatment or reintervention if indicated.[2]

Conclusion

The identification of persons with PAD usually begins in the primary care setting. Many persons with PAD may be managed conservatively without progression of their disease; but when conservative treatment fails or in the case of CLI, intervention by a vascular surgeon can result in the relief of symptoms and limb preservation. It is important for physicians to have an awareness of an at-risk population and to identify individuals with potential PAD for referral.

Surgical intervention may be via endovascular or open bypass graft, depending on anatomical and patient characteristics. Follow-up for recurring symptoms after either method of intervention and maintenance on appropriate medication regimens are important for overall outcome.

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