REVIEW

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Vascular claudication: How to individualize treatment

ABSTRACT

The development of angioplasty and stenting, along with the improvement of surgical procedures, have given physicians more options for treating claudication. However, most patients with intermittent claudication do not need a revascularization procedure, or even angiography. They do need an assessment of their coronary and carotid arteries. We present a treatment approach based on risk factor modification, symptom severity, and the risks and benefits of various procedures.

KEY POINTS

Claudication is a marker for systemic atherosclerosis, and all patients with claudication should undergo a thorough medical evaluation of cardiovascular risk.

The medical treatment of claudication consists of a walking program, risk factor modification (especially smoking cessation), and antiplatelet agents.

Focal aortoiliac or iliac disease should be treated with angioplasty and stenting initially. However, occlusions longer than 5 cm, concomitant aneurysms, and occlusions in the common femoral artery are better handled with surgery.

In femoropopliteal disease, the initial treatment is a prolonged course of medical therapy. If that fails, an endovascular procedure is a reasonable next step.

INTERMITTENT CLAUDICATION—ischemic pain in the legs when walking—is usually due to atherosclerotic narrowing of the arteries supplying the leg muscles. Because claudication decreases one's ability to walk, it also impairs one's social, leisure, and occupational activities, functional ability, and quality of life; in extreme cases it can lead to loss of a limb.

Clinicians today have a wider array of treatment options available, but face more difficult treatment decisions. Traditionally, claudication was treated conservatively with medical therapy; surgical revascularization was reserved for patients with limb-threatening ischemia.

Medical therapy, including walking and stopping smoking, is still the cornerstone of treatment, but percutaneous procedures have evolved rapidly over the past 15 years and provide a less-invasive alternative to surgery. At the same time, surgical procedures also improved: better bypass techniques, anesthesia, and perioperative care have all helped lower operative risk.

While assessing and treating the problem in the legs, physicians should also think about the patient's coronary and carotid arteries, because claudication is a marker for systemic atherosclerosis. All patients with claudication should undergo a thorough medical evaluation of cardiovascular risk.

BASIC CHARACTERISTICS OF CLAUDICATION

Claudication (from the Latin *claudicare*, "to limp") results from inadequate perfusion to exercising muscles. The annual incidence is approximately 20 per 1000 in persons older than 65 years,[1] a population that is increasing.

TABLE 1

USING THE ANKLE-BRACHIAL INDEX TO ASSESS THE SEVERITY OF ARTERIAL OBSTRUCTION

Severity	Ankle-brachial index*
Normal	> 0.90
Mild	0.70–0.89
Moderate	0.50–0.69
Severe	< 0.50

*To calculate the ankle-brachial index, divide the systolic blood pressure in each ankle by the higher of the two systolic pressures in the arms.

Patients with typical symptoms describe a crampy, tightening sensation in the calf when walking; those with aortoiliac disease may also note pain in the thigh or buttocks. The distance a patient can walk before the pain begins is usually consistent from day to day. The pain resolves within minutes of stopping to rest even while standing, a feature that helps differentiate vascular from neurologic problems such as spinal stenosis or disk disease.

Symptoms remain stable or improve in 65% to 70% of patients

Most patients with claudication have narrowing of more than one arterial segment, and most patients with limb-threatening ischemia have multiple atherosclerotic lesions either in tandem (ie, obstructing more than one artery at the same level, such as the profunda and superficial femoral arteries) or at different levels. Diabetes mellitus predisposes to atherosclerosis in the tibial arteries as well as more proximally. Patients younger than 60 years tend to have lesions in the aorta and iliac arteries, whereas older patients tend to have lesions in the superficial femoral artery.

NATURAL HISTORY OF CLAUDICATION

For most patients with claudication, the disease does not progress, and physicians can reassure worried patients that their risk of losing a limb is low. Many large studies have shown that claudication progresses to critical limb-threatening ischemia in only 1.4% of patients per year.[2] Symptoms remain stable or improve with time in 65% to 70% of patients, and fewer than 25% of patients ever need surgery or angioplasty.[2] The reason for this stability is that in chronic ischemia, the arterial circulation compensates by recruiting and enlarging collateral channels. However, symptoms can worsen as atherosclerotic lesions enlarge.

Acute ischemia may be due to an embolus or acute thrombosis of an artery with an immature collateral network. This lack of collateral vessels may lead to more severe ischemia, jeopardizing limb integrity.

A patient's chances for long-term survival depend on the status of his or her cardiovascular system, as claudication is usually a marker of systemic atherosclerosis. On average, the life span of patients with claudication is shortened by about 10 years; the overall mortality rate is 30% at 5 years, 50% at 10 years, and 70% to 75% at 15 years.[3] And three fourths of the premature deaths are due to cardiovascular disease. In one angiographic study, 28% of 1000 patients who presented for surgery for peripheral vascular disease also had *severe* coronary artery disease.[4]

Two risk factors make the prognosis considerably worse: cigarette smoking and diabetes mellitus. Stopping smoking can reduce the 5-year amputation risk 10-fold and decrease the mortality rate by half.[5] Persons with claudication and diabetes have an overall amputation risk of 20% and a 5-year mortality rate of 50%.

EVALUATION

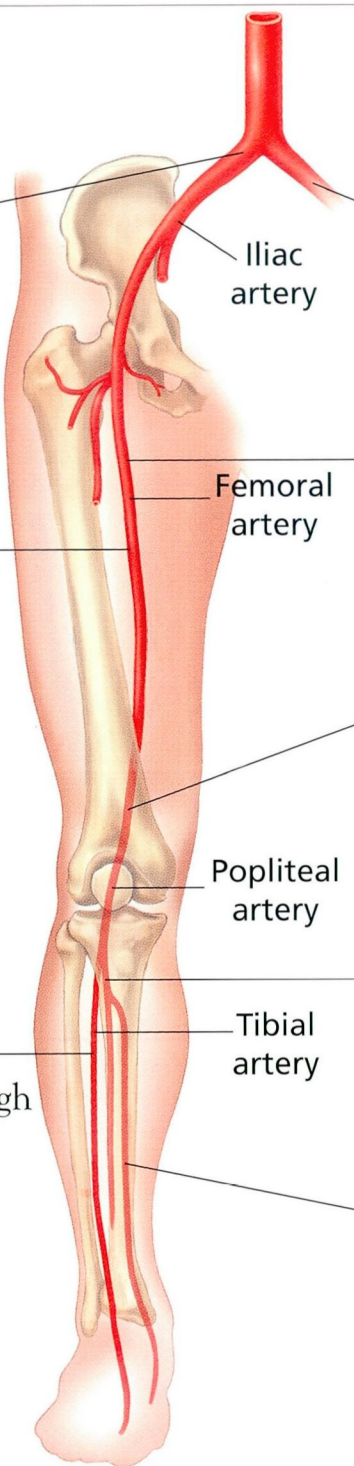
In view of the risks listed above, all patients with claudication should undergo a thorough medical evaluation, including an objective evaluation of cardiovascular risk.

During the evaluation, the primary care physician should:

- Ask whether the problem began suddenly or gradually, how far the patient can walk before the pain begins, and whether the pain is relieved by standing.

FIGURE 1

Angioplasty or surgery? Long-term patency rates



Angioplasty

Aortoiliac angioplasty with stenting
90% initial technical success
73% at 2 years

Superficial femoral or popliteal artery angioplasty (with or without stenting) or thrombolysis
8% to 89% at 3 years
(see **FIGURE 2**)

Tibial angioplasty
Initial technical success rate high
Long-term patency rates poor, based on limited data

Bypass surgery

Aortoiliac replacement, or aortobiiliac or aortobifemoral endarterectomy
80% to 90% at 5 years

Femoral extra-anatomic bypass
60% at 5 years

Femoropopliteal bypass, above the knee
At 5 years:
50% with synthetic grafts
75% with vein grafts

Femoropopliteal bypass, below the knee
At 5 years:
40% with synthetic grafts
74% with vein grafts

Femorotibial bypass
At 5 years:
14% with synthetic grafts
67% with vein grafts

- Assess the quality of the femoral, popliteal, and dorsalis pedis pulses in both legs. This may give a rough idea of the location of the narrowing.
- Note any signs of arterial insufficiency in the legs, such as coolness, scaling, paleness (especially when the leg is elevated), or ulcers.
- Measure the blood pressure in both arms. Then, using a large blood pressure cuff applied to the calf, measure the blood pressure in the ankle.
- Calculate the ankle-brachial index (ABI) by dividing the systolic pressure in each ankle by the higher of the two systolic pressures in the arms. This number gives a rough estimate of the degree of arterial insufficiency, with values lower than 0.9 being abnormal, and values lower than 0.5 reflecting severe obstruction (TABLE 1). It may also give an idea of the probability of atherosclerosis elsewhere in the body; in the coronary angiographic study cited above, the prevalence of severe coronary artery disease was 17% in patients with an ABI greater than 0.75, but 33% in those with an ABI less than 0.25.[4]

Two thirds of the premature deaths are due to cardiovascular disease

In patients with lifestyle-limiting claudication or more severe ischemia (ie, an ABI less than 0.5), noninvasive testing with either pulse volume recording or duplex ultrasonography should be done. Patients with persistent disability or worsening symptoms should be referred to a vascular specialist for consideration of angiography and revascularization.

Cardiovascular and cerebrovascular assessment

Because myocardial events are among the most common adverse outcomes in patients with claudication, the physician should:

- Estimate the patient's risk of coronary artery disease, taking into account his or her family history, smoking history, blood pressure, and low-density lipoprotein level.
- Refer the patient for a functional study such as dobutamine stress echocardiography or thallium imaging to look for reversible coronary ischemia; these tests are preferred to routine coronary arteriography.
- Assess for cerebrovascular disease by referring the patient for an objective test such as duplex ultrasonography of the carotid arteries. Of note, a cervical bruit may be present in only 40% of persons with significant internal carotid artery stenosis.[6]
- Screen for diabetes mellitus with a random blood glucose measurement, followed by a glucose tolerance test if abnormal. If abnormal glucose tolerance is found, the most advanced current therapy should be instituted.

MEDICAL THERAPY

All patients with claudication should receive medical therapy, even if angioplasty or surgical revascularization is contemplated.

Walking

For patients with claudication, physicians should recommend a regular, daily, walking regimen. For 30 to 45 minutes each day, patients should walk as fast and as far as they can. They should stop when the pain becomes nearly unbearable, wait until the pain goes away, and then resume walking.

Walking in this stop-start manner improves calf muscle tone and function (by 120% to 180% in supervised programs), stimulates collateral vascular development, and increases the distance that patients can walk, but it does not increase the ankle-brachial index. According to a meta-analysis, the greatest improvement occurs with sessions lasting longer than 30 minutes, at least three times a week, for at least 6 months, using near-maximal pain as a signal to stop rather than the onset of pain.[7] Surprisingly, patients older than 64 years improve more than do younger patients; there are also trends toward greater improvement in patients with an ankle-brachial index lower than 0.80 vs a higher value, and in patients who have had symptoms for longer vs shorter periods of time.[7]

Risk factor modification

Smoking cessation is mandatory. Of smokers who succeed in quitting, more than 85% enjoy a decrease in symptoms, compared to only 20% of those who continue to smoke.[5] The risk of bypass graft failure in the aortoiliac and femoral arteries is twice as high in smokers as in nonsmokers.[8] Even though the impact of cigarettes is dose-dependent, the

physician should not waver on the need for total abstinence from tobacco.

Aggressive lipid-lowering therapy may halt atherosclerosis and induce plaque regression, as suggested by several studies.[9] To do this, patients need to achieve ideal body weight and, usually, take lipid-lowering medications.

Antihypertensive treatment has not been studied in claudication. Nonetheless, control of hypertension limits vascular complications such as stroke and myocardial infarction. Many patients with claudication and hypertension also have renal artery stenosis, which should be evaluated if suspected.

Antiplatelet agents

Antiplatelet agents complement the other drugs used in risk factor modification.

Aspirin and ticlopidine have been shown to reduce cardiovascular events in patients with claudication, although neither agent alters walking distance, leg circulation, or the progression of disease.

Pentoxifylline (Trental) is the only hemorrheologic agent currently approved by the Food and Drug Administration for patients with claudication. In a prospective, randomized study, patients taking pentoxifylline experienced a 19% increase in walking distance; however, the clinical relevance of this is unknown because this drug has an unpredictable effect in many patients.[10] To maximize cost-effectiveness, we reserve this drug for patients who do not achieve the desired benefit from smoking cessation and walking. A 2-month trial can then identify the 20% who may improve with this therapy.

Ineffective medications for claudication

Medications that have been shown to have *no* impact on walking distance include beta blockers, vasodilators, warfarin, chelation therapy, and ketanserin.

WHICH PATIENTS REQUIRE ARTERIOGRAPHY, REVASCULARIZATION PROCEDURES?

The indication for diagnostic arteriography is lifestyle-limiting claudication, not any specific hemodynamic marker. However, we may be more aggressive in certain situations, depending on the distribution of disease seen on noninvasive testing. For example, a more aggressive approach may be warranted in aortoiliac disease, since excellent revascularization procedures exist for it (FIGURE 1). In addition, patients who continue to smoke or who have diabetes mellitus, multilevel atherosclerotic disease, or a lower ankle-brachial index fare less well with medical therapy. In contrast, extensive tibial disease poses a challenge and may be best managed with continued medical treatment.

CHOOSING THE BEST PROCEDURE FOR THE INDIVIDUAL PATIENT

Only two randomized trials have compared surgical bypass with balloon angioplasty for aortoiliac and femoropopliteal disease.[11,12] These studies concluded that the two procedures lead to similar patency rates and amputation rates, although angioplasty has a higher rate of initial failures and a lower mortality rate.

Consequently, for patients with disease that is amenable to either surgical or endovascular techniques, the decision must be tailored to each patient. Factors to consider are the size, location, and distribution of atherosclerotic lesions, the patient's clinical condition, and the risks and anticipated benefits of each procedure. TABLE 2 lists factors that favor angioplasty; TABLE 3 lists factors that favor vascular surgery.

Cervical bruits are not sensitive for carotid artery stenosis

REVASCULARIZATION OPTIONS FOR AORTOILIAC DISEASE

Focal aortoiliac or iliac disease should be treated with angioplasty and stenting initially. However, occlusions longer than 5 cm, concomitant aneurysms, and occlusions in the common femoral artery are better handled with surgery. Because of the excellent risk-benefit ratio associated with endovascular therapies, it makes sense to intervene early in the disease process in patients with aortoiliac disease.

Balloon angioplasty with stenting

Stents establish and maintain a larger lumen after angioplasty, allow for more complete res-

TABLE 2

CLINICAL VARIABLES THAT FAVOR ANGIOPLASTY

Large, high-flow arteries

Stenoses shorter than 7 cm

Short occlusions
- < 2 cm in the tibial artery
- < 5 cm in the iliac artery
- < 10 cm in the superficial femoral artery

Stenoses uncovered after occlusions are treated with thrombolysis

Nonostial lesions

Concentric, nonulcerative plaques

Patients without diabetes

Less severe ischemia symptoms (claudication vs pain at rest or gangrene)

TABLE 3

CLINICAL VARIABLES THAT FAVOR VASCULAR SURGERY

Long, diffusely stenotic, eccentric lesions

Long occlusions
- > 5 cm in the iliac artery
- > 10 cm in the superficial femoral artery
- > 2 cm in the tibial artery

Occlusions longer than 10 cm

Stenoses adjacent to aneurysms

Tibial occlusive lesions

Lesions causing atheromatous embolism

olution of the pressure gradients and dissection flaps not infrequently seen with standalone angioplasty, and reduce the need for repeat angioplasty.

Patients can walk 120% to 180% farther with training

This procedure has an excellent risk-benefit ratio in aortoiliac disease, with an initial technical success rate of more than 90% and an angiographic patency rate of 73% at 2 years.[13] The mortality rate is less than 1%, and the complication rate is 14%, most of the complications being access site-related and minor.

Favorable factors for success include younger age, lower severity of ischemia, higher severity of stenosis, and patency of the ipsilateral superficial femoral artery. Anticoagulation is not needed after the procedure. The usual hospital stay is overnight, with resumption of full activities within several days.

Surgery

The surgical approach varies according to the arterial segment involved and other factors.

Arterial replacement with a prosthetic graft is indicated for isolated aortoiliac or iliac disease, where a large-diameter conduit is needed.

Endarterectomy procedures (aortobifemoral, aortobiiliac, or aortic) are quite durable, with patency rates of 80% to 90% at 5 years and 75% at 10 years.[14] Failures are due to worsening atherosclerosis or myointimal hyperplasia downstream.

Extra-anatomic bypass (axillofemoral, femorofemoral, or both) is indicated for patients who cannot tolerate an abdominal procedure with aortic cross-clamping. These procedures are less durable, with patency rates of only 60% at 5 years. The mortality risk varies from 1% to 5%, with morbidity rates of 10% or higher.[14] The hospital stay is about 1 week, with return to full activities within 6 weeks.

REVASCULARIZATION OPTIONS FOR FEMOROPOPLITEAL DISEASE

Infrainguinal atherosclerosis most frequently involves the superficial femoral artery. Occlusions in this artery, if symptomatic, usually span more than 5 cm and are the result of thrombosis upon a critical stenosis. The deep femoral artery, if not diseased, compensates by developing collateral vessels to the popliteal artery.

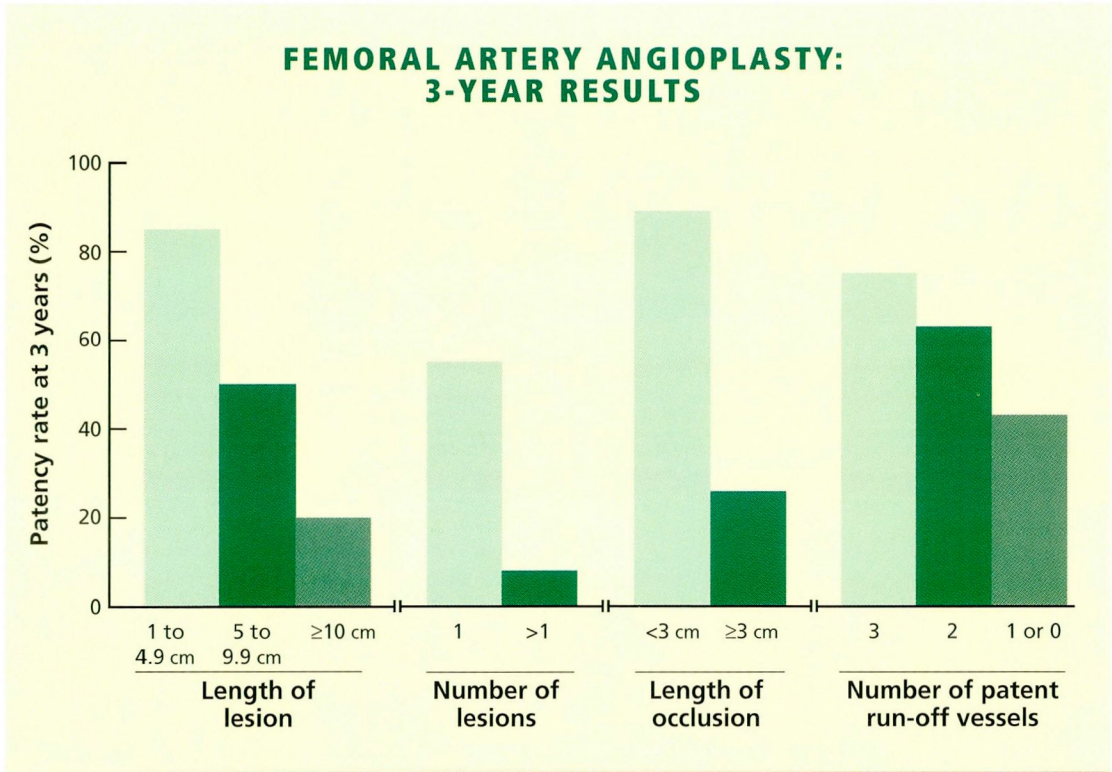


FIGURE 2 Three-year results indicate that angioplasty is more successful in treating femoral artery claudication when the length of the lesion is shorter, when there are a greater number of patent run-off vessels, when there is only one lesion, and when the length of the occlusion is less than 3 cm.

The initial treatment is a prolonged course of medical therapy. If that fails, an endovascular procedure is a reasonable next step. Surgery is reserved for chronic long-segment occlusions or after failed endovascular intervention. In patients at high surgical risk and with long-segment disease, continuation of medical therapy is appropriate.

Endovascular procedures

The endovascular treatment options include angioplasty with or without stents and thrombolysis with adjunctive angioplasty. Directional or rotational atherectomy and laser angioplasty have not fared well and should not be considered as standard options.

Superficial femoral artery angioplasty is a reasonable initial procedure in patients with claudication after a prolonged trial of medical therapy, provided there is only one, short lesion (FIGURE 2). Surgery can be reserved for chronic long occlusions or failed interventional procedures. In patients deemed poor surgical candidates with long lesions, continued medical therapy is appropriate.

Adverse factors include occlusions longer than 10 cm, diabetes mellitus, and concomitant tibial artery disease. A thrombus in the diseased segment can embolize with angioplasty and should be removed before the procedure with thrombolysis or a rheolytic catheter thrombectomy.

Stenting of the superficial femoral artery should be used selectively. Short or focal lesions fare well with stenting; however, long stented lesions frequently occlude or stenose again.[15]

Patients must stop smoking to improve

Thrombolysis. The success of thrombolysis depends on traversal of the occluded segment; optimally, the procedure should be done within 14 days of occlusion.[16] The risk of major complications with this intervention is low (< 5%). If the procedure fails, patients merely revert to their previous claudication status. The hospital stay is generally overnight with no limitation to activities after several days.

Long-term medical therapy is appropriate for isolated tibial disease

Surgery

Candidates for reconstructive femoropopliteal bypass are patients with severe lifestyle-limiting claudication and long occlusions.

The 5-year patency rates of femoropopliteal bypass are higher with autologous vein grafts than with synthetic grafts: approximately 75% vs 50%. Synthetic grafts fare even worse more distally: the 5-year patency rate is approximately 14% for synthetic tibial grafts vs 67% for autologous tibial grafts. Therefore, if the distal anastomosis is above the knee, either a synthetic or an autologous vein graft is acceptable. Synthetic grafts below the knee should be reserved for desperate situations, not stable claudication.

The operative mortality rate is between 1.7% and 3.5%, with morbidity rates around 10%.[17] Critical limb ischemia can result from bypass thrombosis, escalating amputation risk if uncorrected. Hospital stays are between 4 and 7 days, with resumption of full daily activities within 4 weeks.

SHOULD TIBIAL DISEASE BE LEFT ALONE?

Long-term medical therapy is appropriate for isolated tibial disease. The minority of patients whose condition worsens to limb-threatening ischemia should then undergo surgical revascularization.

We advocate this less-aggressive approach because tibial revascularization in general carries a lower patency rate and a higher amputation risk with failed procedures.[18]

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