Percutaneous Interventions for Lower-Extremity Peripheral Atherosclerotic Disease

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Patients with peripheral arterial disease frequently develop symptoms of claudication that interfere with ambulation and adversely affect quality of life, and some develop critical limb ischemia. Many of these patients have coexisting coronary artery disease, and surgical revascularization poses risks of perioperative myocardial infarction and cardiovascular death. Peripheral catheter-based interventions are a feasible alternative. Percutaneous treatment can preserve the surgical option and is often used as an adjunct to surgery by addressing inflow stenoses and limiting the extent of surgical reconstruction that is necessary. Iliac artery balloon angioplasty has been shown to have a high rate of initial procedural success and long-term patency, and the use of stents is promising, especially in cases complicated by flow-limiting dissection or significant residual stenosis. Percutaneous revascularization of the femoropopliteal arteries has shown high restenosis rates and stents should be confined, at present, to flow-limiting dissections or inadequate results from balloon angioplasty alone. The indication for percutaneous revascularization below the knee is typically limited to those patients with critical limb ischemia who are at high risk for surgical reconstruction; short-term results with modern equipment have been promising and can salvage ischemic limbs. [Rev Cardiovasc Med. *2001;2(3):120–125*]

Key words: Peripheral arterial disease • Intermittent claudication • Critical limb ischemia • Percutaneous interventional strategies • Balloon angioplasty

Patients with peripheral arterial disease (PAD) frequently develop symptoms of claudication that interfere with ambulation and adversely affect quality of life. A minority of patients has critical limb ischemia, causing rest pain, ulceration, or tissue necrosis. Atherosclerotic disease of the iliofemoral and crural vessels is the primary substrate for symptomatic PAD. Risk factor modification, antiplatelet agents, a supervised exercise regimen, and treatment with agents such as pentoxifylline or cilostazol have been advocated by

clinicians as first-line therapies for lower-extremity claudication. Progressive symptoms, disabling claudication, and critical limb ischemia often dictate more aggressive therapy, such as surgical reconstruction. Yet consideration of surgical revascularization must take into account the risk of perioperative myocardial infarction and cardiovascular death, given that many of these patients have coexisting coronary artery disease. Peripheral catheter-based interventions are a feasible option for an increasing number of patients with symptomatic PAD. This review will discuss the rationale for percutaneous interventional strategies and interventional outcomes in patients with PAD.

Patients with lifestyle-limiting claudication are now being referred for angiographic investigation and potential catheter-based intervention.

Although surgical options have traditionally been reserved for patients with limb-threatening ischemia and rest pain, the lesser procedural risk associated with most endovascular therapies has lowered the threshold for intervention. The perceived cost reduction with percutaneous versus surgical therapy has bolstered its popularity as well.[1] Thus patients with lifestyle-limiting claudication are now being referred for angiographic investigation and potential catheter-based intervention. Percutaneous treatment usually preserves the surgical option should it be needed and is often used as an adjunct to surgery by addressing inflow stenoses and limiting the extent of surgical reconstruction that is necessary.[2] An increasingly aware patient population will often opt for percutaneous catheter–based therapies, accepting results that may be less durable or even less efficacious than those with a more invasive surgical approach.

The natural history of PAD and the likelihood of a successful and durable percutaneous treatment are dictated in great part by the anatomic locale. Therefore, in this review, the approach to catheter-based treatment for patients with lower-extremity peripheral vascular disease is considered separately for aortoiliac, femoropopliteal, and infrapopliteal segments. Noninvasive modalities, such as segmental limb pressure measurements, duplex ultrasonography, and magnetic resonance angiography are useful for localizing diseased arterial segments and evaluating the severity of arterial lesions. Angiography is indicated to plan revascularization in patients with progressive or disabling symptoms or ischemic rest pain, with the ultimate goals of percutaneous and operative therapy being relief of ischemic symptoms and limb salvage.

Obstruction of the iliac artery and its branch vessels may cause claudication of the buttocks, thighs, and calves.

Iliac Artery Disease

Obstruction of the iliac artery and its branch vessels may cause claudication of the buttocks, thighs, and calves (Figure 1). While many patients with iliac artery disease have concomitant femoropopliteal and tibioperoneal lesions, treatment of iliac obstruction is often undertaken first with hopes of providing symptomatic improvement. The mechanisms of clinical benefit include elevation of the perfusion pressure even when tandem distal stenoses are present, and increased potential for collateral blood flow to the distal part of the extremity when arterial lesions are present beyond the diseased iliac segment. From a technical standpoint, iliac artery balloon angioplasty has been shown to have a high rate of initial procedural success and long-term patency. Gupta and colleagues reported marked improvement in ankle/arm index (with improvement ranging from 0.16 to 0.91 postprocedure), improved wound healing in 57% of patients, relief of rest pain in 67% of patients, and relief of claudication in 79% of patients.[3] Three-year success rates for recanalized iliac artery occlusions are as high as 73% in patients with good distal arterial runoff and less than half of this value (30%) in those with poor distal runoff.[4] Of note is that one comparison of 3-year patency rates in patients treated with angioplasty versus surgery for iliac artery stenoses showed no significant difference.[5]

Technical consideration of iliac artery lesions must take into account the length of the lesion and whether it is stenotic or completely obstructive. Early studies of percutaneous recanalization of occluded iliac arteries demonstrated poor results with high complication rates. The advent of hydrophilic guidewires and other technical advances has allowed the recanalization of

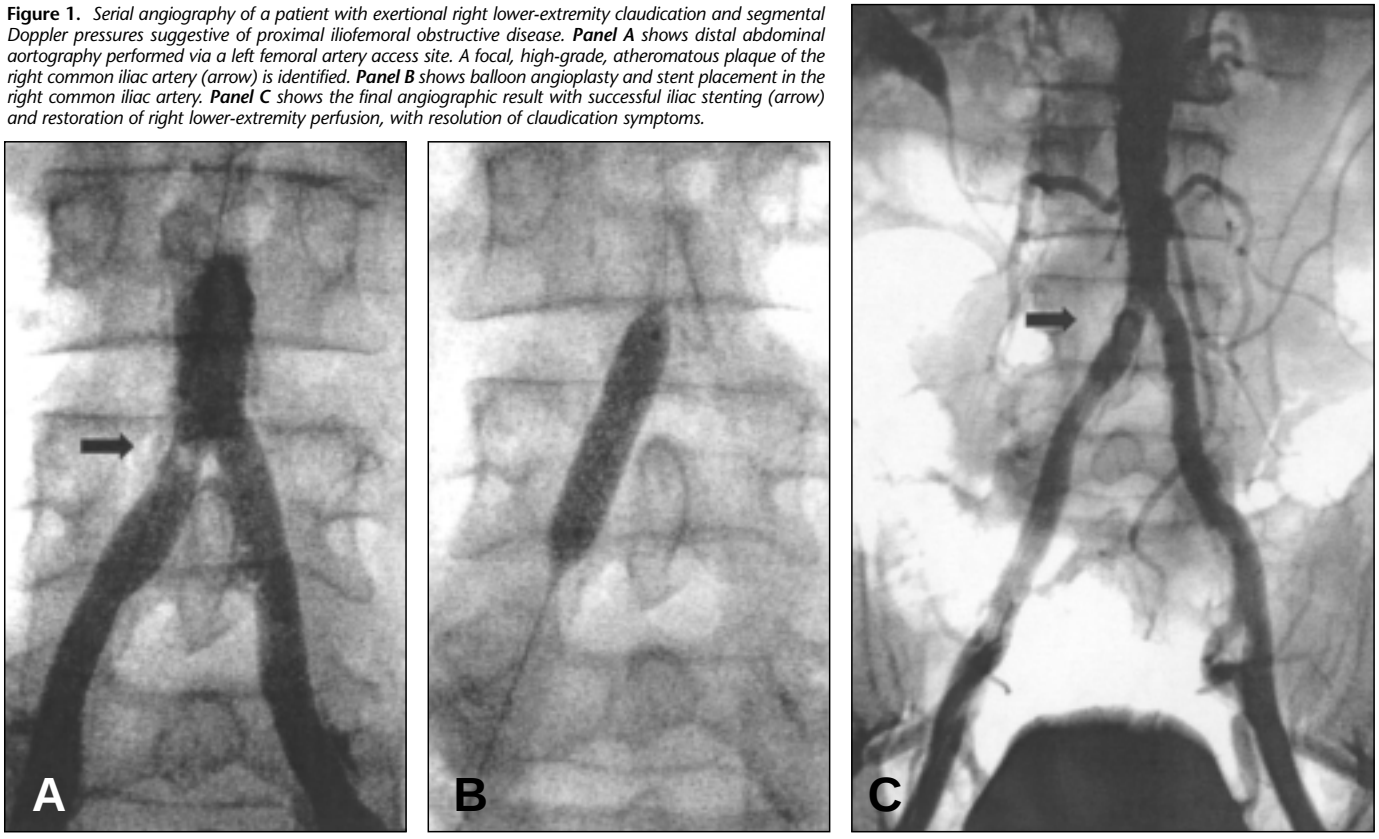
occluded iliac segments with an estimated 88% rate of primary success independent of location (external, internal, or common iliac artery).[6,7] Late results are equally impressive, with a secondary patency rate of 77% at 6-year follow-up.

The natural history of stenting in this territory is quite promising, with angiographic restenosis rates of 0.5% at 6 months and a 4-year primary patency rate of 86%.[8] Intravascular stents are used selectively to improve long-term outcomes of iliac percutaneous transluminal angioplasty (PTA). Tetteroo and colleagues examined 279 patients with intermittent claudication and randomized those patients with significant (more than 50%) iliac stenoses to a strategy of primary stent placement versus primary PTA, with provisional stenting only if a translesional gradient persisted after initial balloon dilatation.[9] These investigators found that the rates of initial hemodynamic success and procedural complications as well as clinical success rates at two-year follow-up were not significantly different between the treatment groups. Other investigators have found similar results with primary stent placement compared to balloon angioplasty alone.[10,11] Most operators would likely favor the use of stents in cases complicated by flow-limiting dissection or significant residual stenosis. Though the ease of stent placement has bolstered its popularity, there is still insufficient evidence to advocate primary stent placement as unquestionably superior to balloon angioplasty alone for iliac artery disease.

Distal embolization continues to be among the most common serious complications associated with recanalization of iliac artery occlusions, with rates ranging from 4% to 7% in one series.[12] Thrombolytic therapy combined with balloon dilatation or primary stent placement in an attempt to avoid embolic complications has been proposed but requires further investigation.[13,14] Covered stents are now being used for iliac artery lesions associated with aneurysm or anatomic complexities and may increase the applicability of percutaneous therapy.

Considerable published data support the use of percutaneous techniques for the relief of occlusive disease of the iliac vessels, as the rates of procedural success and long-term durability are similar to those achieved with surgical reconstruction. Well-designed, random-

Figure 1. *Serial angiography of a patient with exertional right lower-extremity claudication and segmental Doppler pressures suggestive of proximal iliofemoral obstructive disease.* ***Panel A*** *shows distal abdominal aortography performed via a left femoral artery access site. A focal, high-grade, atheromatous plaque of the right common iliac artery (arrow) is identified.* ***Panel B*** *shows balloon angioplasty and stent placement in the right common iliac artery.* ***Panel C*** *shows the final angiographic result with successful iliac stenting (arrow) and restoration of right lower-extremity perfusion, with resolution of claudication symptoms.*



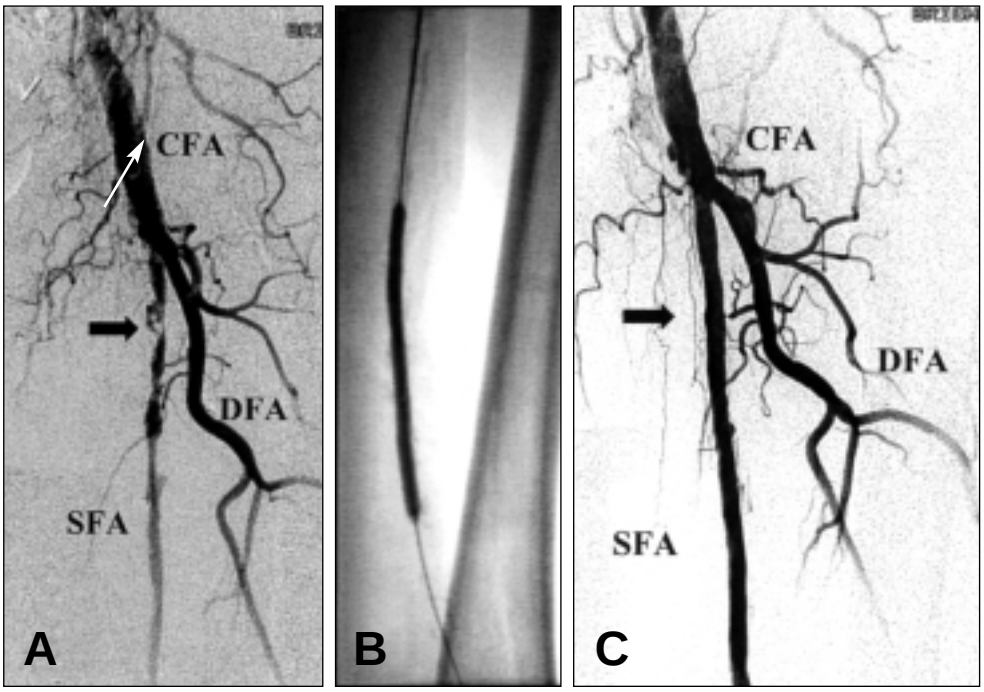


Figure 2. *Serial angiography of a patient with disabling left-calf claudication despite attempts at medical management.* ***Panel A*** *shows selective left femoral angiography accomplished via a retrograde right femoral approach. The distal portion of the common femoral artery (CFA), proximal segment of the superficial femoral artery (SFA), and deep femoral artery (DFA) are delineated. A focal, severe stenosis of the proximal SFA (arrow) and subsequent diffuse, moderate, obstructive disease are demonstrated. This diseased segment of the SFA was treated with balloon angioplasty and subsequent stent placement due to flow limiting dissection and an inadequate balloon result.* ***Panel B*** *shows balloon inflation within the stented segment.* ***Panel C*** *shows the final angiographic result without significant residual stenosis (arrow) at the site of intervention. Good distal arterial runoff was present via a patent distal SFA with patent crural vessels (not shown).*

ized, controlled trials of catheter-based versus operative iliac revascularization are still needed.

Femoropopliteal Disease

The external iliac artery becomes the common femoral artery as it courses below the inguinal ligament, subsequently branching into the superficial femoral artery and the deep femoral artery. The superficial femoral artery (SFA) is a particularly common site for the occurrence of infrainguinal atherosclerotic disease (Figure 2), particularly that portion of the SFA that lies within the adductor canal of the thigh. Enthusiasm for percutaneous revascularization of the femoropopliteal arteries has been tempered by concerns of high restenosis rates. Henry and colleagues report an 11% restenosis rate in SFA lesions treated with balloon dilatation and stenting, and a 20% restenosis rate for similarly treated popliteal lesions at 6-month angiographic follow-up.[8] Long-term observation indicates a four-year patency rate of 65% for SFA lesions, and 50% for popliteal lesions.[8] Matsi and colleagues reported high rates of initial procedural success but primary patency rates in patients with SFA stenoses and recanalized total occlusions of less than 50% at 1 to 3 years as judged by clinical follow-up.[15]

These values and those from other investigators are similar to those reported by Henry and colleagues when a strategy of primary stent placement was used in this anatomic locale.[8,12] There is little evidence to support the superiority of endovascular stents over PTA alone in the femoropopliteal arteries. Their use should be confined, at present, to flow-limiting dissections or inadequate results from balloon angioplasty alone.[16–18]

Several factors may help predict outcome after catheter-based intervention in this anatomic locale. The length and severity of a diseased segment affects late outcome after intervention in the superficial femoral artery. Capek and colleagues showed that lesion length correlated with outcome, with short lesions faring better, with improved long-term patency, than long lesions (defined as over 10 cm).[19] Overall vessel patency rates after femoropopliteal angioplasty were 81%, 61%, and 58% at 1, 3, and 5 years in this same study.[19] Percutaneous treatment of totally occluded SFA and popliteal arteries has been associated with twofold higher complication rates than dilation of stenosed but patent segments.[19] The long-term patency rate of SFA total occlusions is lower than that of stenosed segments.[15] The presence of good distal runoff seems to predict improved late patency.[20] The role of thrombolytic therapy in the management of SFA occlusions, both acute and subacute, remains to be elucidated.

Femoropopliteal interventions, then, are associated with high rates of initial success but only modest

long-term patency. The role of endovascular stenting in this locale is a matter of ongoing investigation. However, current data do not support the use of stents in all femoropopliteal interventions. Despite concerns over restenosis in this anatomic locale, SFA intervention may still be considered in patients at high risk for surgical therapy in order to improve wound healing and for symptomatic relief.

Tibial-Peroneal Disease

The crural, or infrapopliteal, arteries provide blood flow to the gastrocnemius and soleus muscles of the calf, as well as to the arterial arcade of the foot. While these vessels are a common site of arterial disease, single or multiple stenoses of one crural vessel rarely provoke calf claudication. Rather, significant disease of all three infrapopliteal arteries (anterior tibial, peroneal, and posterior tibial) is usually required to provoke symptomatic ischemia in the absence of proximal flow-limiting disease of the iliofemoral vessels. Lesions of the crural arteries are found more typically in association with disease of more proximal vessels, resulting in sequential lesions that reduce perfusion pressure and increase the likelihood of symptoms. Consideration of the management of distal disease is important given its common occurrence in patients with nonhealing foot ulcers.

The indication for percutaneous revascularization below the knee is typically limited to those patients with critical limb ischemia who are at high risk for surgical reconstruction. Short-term results with modern equipment have been promising, with primary success rates as high as 96% in one study, and a cumulative patency rate of 75% after 2 years.[21] Although there have been particular concerns regarding small-vessel interventions in diabetic patients, there is evidence that balloon angioplasty of the crural vessels can salvage ischemic limbs in this population[22] as well as in other nonselected cohorts with limb-threatening ischemia.[23-28] If straight-line flow can be restored to the foot via at least one calf vessel, prompt clinical improvement is the rule.[29] However, the presence of diabetes, total occlusion of crural vessels, surgical bypass grafts, multilevel disease, and poor distal runoff all predict a less favorable short- and long-term outcome after tibioperoneal balloon angioplasty.[2,19,25,30,31] In general, such efforts still preserve surgical options if needed.[2] Overall, infrapopliteal interventions are characterized by high rates of technical success and the potential to achieve better distal arterial runoff, symptomatic improvement, and even limb salvage, despite the specter of high rates of late restenosis and reocclusion.

Table 1
Indications for Percutaneous Peripheral Artery Revascularization

For Aorto-Iliac Disease:
Lifestyle-limiting claudication
Improved wound healing
Proximal revascularization before femoral-distal bypass (hybrid procedure)

For Femoropopliteal Disease:
Limiting claudication unresponsive to conservative measures
Patients at high operative risk
Improved wound healing

For Tibioperoneal Disease:
Preservation of distal runoff after proximal intervention
Improved wound healing
Limb salvage

Conclusions

Percutaneous catheter–based interventions are appropriate in selected patients with arterial disease and associated symptoms (Table 1). While in isolated iliac occlusive disease, endovascular treatment is equivalent hemodynamically and may be preferable to surgery, infrainguinal disease is often diffuse, and extensive long-segment femoral obstructive disease may be best addressed by surgical bypass. For select high-risk patients in whom severe coronary artery disease coexists with peripheral arterial disease, a less invasive endovascular approach may be a preferable first step. Catheter-based therapy should be considered an effective component of comprehensive medical therapy in patients with lower-extremity arterial disease. The decision to proceed with percutaneous intervention should entail a frank physician-patient discussion of the risk, potential symptomatic benefit, and durability of the proposed intervention tailored to anatomic locale.

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Main Points

- Iliac artery balloon angioplasty has a high rate of initial success and long-term patency associated with improved ankle/arm index, wound healing, and relief of claudication.
- The iliac artery has an angiographic 6-month restenosis rate of 0.5% and 4-year patency of 86%.
- Provisional stent implantation for iliac artery disease with a residual translesional gradient has similar results as primary stent placement.
- Use of stents in treating femoropopliteal disease should be confined to flow limiting dissections or inadequate results from angioplasty alone.
- Infrapopliteal interventions are characterized by high rates of technical success and enhancement of distal arterial runoff, and result in limb salvage.