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Critical Limb Ischemia: Endovascular Strategies for Limb Salvage

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Abstract Critical limb ischemia (CLI) represents the most severe clinical manifestation of *peripheral arterial disease*, defined as the presence of chronic ischemic rest pain, ulcers, or gangrene attributable to objectively proven arterial occlusive disease. The dominant pathology underlying CLI is atherosclerosis, distributed at multiple levels along the length of the lower extremity and with a propensity for involvement of the tibial vessels in the leg and the small vessels of the foot. To achieve limb salvage in patients with CLI, revascularization of the affected limb is generally required. In contemporary practice, endovascular techniques are rapidly replacing surgical bypass as the first option for revascularization for CLI based on high technical success rates and low rates of procedure-related morbidity and mortality. This review will describe the clinical strategy of the authors who have adopted an endovascular-first approach to revascularization in treating patients with CLI and summarize the clinical outcomes of endovascular therapy in this population. (Prog Cardiovasc Dis 2011;54:47-60)

Keywords: Peripheral arterial disease; Revascularization; Endovascular; Critical limb ischemia

Critical limb ischemia (CLI) represents the most severe clinical manifestation of peripheral arterial disease (PAD) (Fig 1).[2] It is defined as the presence of chronic ischemic rest pain, ulcers, or gangrene attributable to objectively proven arterial occlusive disease (Fig 2). An important component of the definition of CLI is that symptoms must be long term, lasting a minimum of 2 to 4 weeks.[3] The dominant pathology underlying CLI is atherosclerosis. When compared with patients with claudication, the burden of atherosclerosis in patients with CLI is greater. Multilevel disease with a propensity for involvement of the tibial vessels in the leg and the small vessels of the foot is typical (Figs 3 and 4).[4,5] To achieve limb salvage in patients with CLI, revascularization of the affected limb is generally required. During the last decade, endovascular techniques have gained increasing popularity over bypass surgery as the primary mode of revascularization.[6,7] This review will describe the clinical strategy of the authors who have adopted an endovascular-first approach to revascularization in treating patients with CLI and summarize the clinical outcomes of endovascular therapy in this population.

Defining the primary treatment strategy in CLI

In approaching a patient with CLI, several questions should be asked that will help form the foundation for the decision regarding the appropriate primary treatment strategy.

- Is the limb salvageable?
- Is the limb worth saving?
- Is revascularization possible?
- What is the risk-benefit ratio of revascularization?

These questions are interrelated and reinforce the complexity of the decision-making process that is best performed by a multidisciplinary team of health care

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Abbreviations and Acronyms

ABI = ankle brachial index

BASIL = Bypass versus Angioplasty in Severe Ischemia of the Leg

CFA = common femoral artery

CLI = critical limb ischemia

CT = computed tomography

MR = magnetic resonance

PAD = peripheral arterial disease

PVRs = pulse volume recordings

SLP = segmental limb pressures

specialists.[2] The answer to each of these questions is derived from a careful assessment of several patient, limb, and arterial anatomic variables (Table 1). A full discussion of the impact of each of these variables on decision making is beyond the scope of this review, but a flavor of the impact of these variables is provided in Table 1. Although the greatest chance of limb salvage occurs in patients with arterial anatomy amenable to revascularization and who achieve successful revascularization, it needs to be appreciated that some patients are better served with primary amputation (eg, 90-year-old patient with significant renal insufficiency, a contracture of the knee in the limb with CLI, extensive gangrene of the foot, and who is typically confined to bed); and others may be best served with wound care alone (eg, 70-year-old patient with creatinine of 3.0 mg/dL and small nonhealing wound at tip of digit with no associated infection). Significant clinical experience is required in synthesizing the clinical and anatomic data and arriving at clinical decisions that maximize rates of limb salvage with a minimum of overall patient morbidity and mortality. The enthusiasm to achieve revascularization needs to always be tempered by the goal of achieving the best global outcome for the patient.

Assessment of patient with CLI

Clinical

The clinical assessment of a patient with CLI should focus on the patient and limb variables outlined in Table 1. In addition, a careful clinical evaluation of the arterial flow to both lower extremities is mandatory, with documentation of palpable pulses and Doppler signals from the main arteries (ie, common femoral, popliteal, posterior tibial, and dorsalis pedis). Evaluation of both lower extremities is important as CLI is often a bilateral process, and arterial access to the affected limb for diagnostic angiography or revascularization procedures is often achieved via the contralateral limb. It is important to have a high index of suspicion for associated soft tissue infection and/or underlying bony infection (ie, osteomyelitis) in patients with CLI. The authors have a low threshold for proceeding to imaging studies (eg, plain x-ray, magnetic resonance [MR] foot, bone scan) to screen for evidence of underlying osteomyelitis.

Hemodynamics

In all patients with CLI, the authors recommend a full hemodynamic evaluation of both lower extremities that includes recording of the ankle brachial index (ABI), segmental limb pressures (SLPs), pulse volume recordings (PVRs), and toe pressure. The use and limitations of each of these parameters in relation to the assessment of patients with CLI are as follows:

Ankle brachial index

Although the ABI is widely accepted as a useful tool to screen for the presence of hemodynamic disease in the lower extremity arteries between the level of the distal abdominal aorta and the ankle, it has significant limitations in patients with CLI. Among patients with CLI, the high incidence of tibial calcification results in a high incidence of uninterpretable ABI readings (ie, ABI >1.3) (Fig 5). Less well appreciated is the significant proportion of patients with CLI who have an ABI within the range suggesting normal arterial flow (0.9-1.29) or mild to moderate disease (0.41-0.89) that may be falsely reassuring (Fig 5). This phenomenon may be due to lesser degrees of tibial calcification or to the specific arterial anatomy of the patient. For example, a patient with an occlusion of the tibioperoneal trunk and a patent anterior tibial artery that becomes occluded more distally at the level of the dorsalis pedis artery can have a normal ABI because of the patent anterior tibial artery at the level of the ankle. Therefore, although an ABI of 0.4 or less or an absolute ankle pressure 50 mm Hg or less is generally considered to be consistent with a diagnosis of CLI and therefore helpful in confirming the diagnosis of CLI, the authors are not

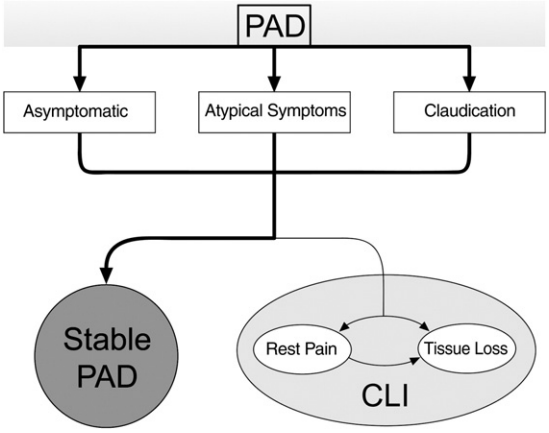

Fig 1. Schematic of typical clinical presentation and progression of PAD. Note that the progression of PAD to CLI occurs in a minority of all patients with PAD (1%-2%). Reproduced with permission from Casserly.[1]