Inframalleolar Intervention for Limb Preservation

Javier A. Valle, MD, MSc[a], Andrew F. Prouse, MD[b], Robert K. Rogers, MD, MSc, RPVI[c,*]

KEYWORDS

• Critical limb ischemia • Endovascular interventions • Pedal interventions
• Inframalleolar interventions • Limb salvage • Peripheral vascular disease

KEY POINTS

- Critical limb ischemia (CLI) portends a high risk of amputation and death. Revascularization is a mainstay of therapy for patients with CLI.
- There is a high prevalence of tibioperoneal and pedal arterial disease in patients with CLI.
- Advanced endovascular therapies are evolving to revascularize distal, small-vessel disease.
- The ability to revascularize inframalleolar arterial disease is improving due to increased operator experience and emerging technologies; however, there remains an evidence gap in this field.

INTRODUCTION

Critical limb ischemia (CLI) is defined as ischemic rest pain or tissue loss in the setting of reduced limb perfusion. CLI is a relatively prevalent condition, estimated to occur in 35 per 10,000 patients annually[1] in the United States, and is associated with significant morbidity and poor outcomes. Retrospective analyses of patients suffering from CLI have demonstrated a risk of amputation up to 67% at 4 years[2] and a 2-year mortality of nearly 40%.[3] Even in the setting of regular follow-up provided in clinical trials, patients with CLI who are unable to undergo revascularization have amputation rates of 21% and mortality rates of 15% at 1 year.[4] Given the poor prognosis these patients face, improved CLI therapies are needed.

Revascularization is a mainstay of CLI therapy. Unfortunately, many patients with CLI are considered unsuitable for revascularization. Surgical options are often limited by prohibitive operative risk in this patient population with a high prevalence of comorbidities such as diabetes mellitus, active tobacco use, increased age, renal failure, and coronary or cerebrovascular disease.[4,5] A second challenge of surgical revascularization is the high prevalence of tibioperoneal and pedal disease in CLI, which comprises distal bypass targets. For example, in a retrospective study of 450 patients with CLI undergoing catheter-based angiography at 2 academic institutions, the prevalence of popliteal or infrapopliteal occlusions was 91%.[6] The high prevalence of diabetes mellitus in CLI populations undoubtedly contributes to this preponderance of small-vessel disease.[7]

For these reasons, endovascular therapy for CLI has gained appeal. Bolstering the enthusiasm for percutaneous strategies is the concept of "angiosomes," wherein each below-knee vessel is considered responsible for perfusing distinct areas of the lower extremity. Based on this concept, clinicians have more recently invoked

Dr R.K. Rogers is on the adjudication committee for VOYAGER, funded by Bayer. Dr J.A. Valle is a subinvestigator for VOYAGER, funded by Bayer.

[a] Division of Cardiology, University of Colorado School of Medicine, 12361 East 17th Avenue, Box 130, Aurora, CO 80045, USA; [b] Division of Cardiology, University of Colorado School of Medicine, University of Colorado, Mail Stop B132, Academic Office 1, Office 7104, Aurora, CO 80045, USA; [c] Vascular Medicine & Intervention, Interventional Cardiology, Division of Cardiology, University of Colorado School of Medicine, University of Colorado, Mail Stop B132, Leprino Building, 12401 East 17th Avenue, Room 560, Aurora, CO 80045, USA
* Corresponding author.
E-mail address: kevin.rogers@ucdenver.edu

Intervent Cardiol Clin 6 (2017) 261–270
http://dx.doi.org/10.1016/j.iccl.2016.12.009

an angiosome-driven approach to revascularization, specifically targeting the vessel believed to provide direct blood flow to a wound.[8,9] As such, operators increasingly perform tibioperoneal and pedal interventions with the goal of providing direct, in-line flow to the angiosome of interest, rather than only revascularizing the aorto-iliac or femoral-popliteal "inflow." This increased experience, coupled with devices designed for pedal intervention, are establishing a new paradigm for CLI therapy.

In this review, we describe an approach to pedal interventions. An overview of the assessment of foot perfusion is provided, followed by a review of devices for inframalleolar intervention, procedural considerations, and emerging techniques.

ASSESSMENT OF FOOT PERFUSION

The ability to assess pedal perfusion accurately is a major challenge in the field of CLI. Nonetheless, it is critical for the interventionalist to consider foot perfusion for multiple reasons:

- To identify patients with poor perfusion in the angiosome of interest who might benefit from revascularization.
- To identify patients with seemingly adequate perfusion who may not benefit from revascularization and who would be exposed unnecessarily to procedural risks.
- To select a target vessel for revascularization.
- To understand when revascularization is complete versus when further endovascular therapy should be pursued.

Various modalities for assessing pedal perfusion are listed in Table 1. The ideal test for pedal perfusion would be inexpensive, readily available, reproducible, and improve the clinician's ability to predict outcomes. Additionally, the ideal test would be "angiosome-specific"; that is, perfusion data could be obtained from any angiosome of interest in the foot. Currently, there are limitations of each modality for assessing pedal perfusion, and more research is needed in this field (Fig. 1).

TECHNOLOGY FOR INFRAMALLEOLAR INTERVENTION

Devices dedicated for pedal intervention are emerging (Table 2). Angioplasty balloons are now available for small-diameter arteries in the foot with sufficient shaft lengths to reach the foot from contralateral femoral access. Likewise, several atherectomy devices may increase technical success rates for pedal intervention. Specific access kits also exist for the foot. Finally, a platform for arterialization of infrapopliteal veins is being tested (Fig. 2).

PROCEDURAL CONSIDERATIONS FOR INFRAMALLEOLAR INTERVENTION

Access

When considering access, it should be recognized that most pedal lesions to be treated are occlusions, rather than stenoses, and may or may not be contiguous with supramalleolar occlusions. Choosing site(s) that allow access to the proximal and distal caps of the occlusion can increase the chance of procedural success. Although contralateral femoral access is an option for pedal revascularization, the authors rarely choose this access site because of limitations in the length of equipment and decreased catheter "pushability" compared with ipsilateral limb access. Rather, nontraditional access is often obtained.

Table 1
Modalities for assessing pedal perfusion

Modality	Advantages	Disadvantages
Ankle-brachial index	Inexpensive Readily available Large evidence base	Noncompressibility Not consistent with angiosome hypothesis
Toe pressure	Inexpensive Readily available	Does not provide information on all parts of the foot
Transcutaneous oximetry	Provides angiosome-specific data	Large coefficient of variation
Skin perfusion pressure	Provides angiosome-specific data	Limited evidence base Little correlation with outcomes
Two-dimensional perfusion imaging	Provides intraprocedural, angiosome-specific data	Emerging technology with limited evidence base and no correlation with outcomes