A Tactical Approach to Arterial Access for Critical Limb Ischemia

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Abstract: Critical limb ischemia (CLI) is associated with very high morbidity and mortality. Patients with CLI tend to have multilevel disease, often extending both above (inflow) and below the knee (outflow). This manuscript looks at the technical aspects and techniques useful to successfully treat these patients and improve the chances for a good outcome.


Key words: peripheral arterial insufficiency, iliac, femoropopliteal, anterior tibial artery

Critical limb ischemia (CLI), characterized clinically by rest pain or tissue loss resulting from peripheral arterial insufficiency, is the end stage of peripheral artery disease (PAD). As incidence of diabetes and chronic kidney disease has increased, PAD has emerged as a significant public health challenge worldwide. Patients with CLI have poor long-term mortality and morbidity. Patients with CLI who undergo major limb amputation often have worse outcomes, which has led to efforts directed towards limb salvage procedures. A number of technical challenges emerge when treating patients with CLI that an interventionalist should consider when planning and executing revascularization procedures. Patients with CLI tend to have multilevel disease that often extends both above (inflow) and below the knee (outflow) (Figure 1). The goal of revascularization procedures is often to restore in-line blood flow to targeted regions guided by specific angiosomes. The ability to obtain adequate and appropriate arterial access is essential to successfully treat CLI endovascularly.

Lesions of the iliac arteries

The right and left common iliac vessels arise from the abdominal aorta at the level of the L4 vertebra. This is the main vessel of the pelvis and supplies the pelvic viscera. Branches of this vessel also supply the buttocks and perineum. The common iliac further divides into the external and internal iliac vessels. Lesions of these vessels are commonly encountered when treating patients (especially tobacco smokers) with PAD. To treat blockages of the common, internal, and external iliac arteries, access can be obtained from an antegrade and/or retrograde approach. By accessing the contralateral common femoral artery and going up and over the iliac bifurcation, lesions of the iliac artery can be successfully crossed and treated. This approach works well when the target lesion is distal to the bifurcation of the aorta and common iliac artery. If the target lesion is more proximal, such as a flush occlusion of the common iliac artery at the level of the aorta, then a retrograde approach from the ipsilateral common femoral artery can be utilized. In using a traditional, contralateral antegrade approach, one might lose support when trying to cross and treat the lesion. In such cases, brachial or radial access can be used. The left arm is preferred in order to avoid crossing the great vessels arising from the ascending aorta and is a more direct line into the lower extremities (Figure 2).

Lesions of the femoropopliteal arteries

Blockages of the superficial femoral artery (SFA) and the popliteal artery are commonly encountered. Contralateral common femoral artery access (CFA) or antegrade CFA access is often used to approach the lesion. The main benefit of an antegrade approach compared with a contralateral retrograde CFA approach is the stability and support it affords when crossing and treating lesions. This approach is difficult when a flush occlusion is encountered because of lack of space to place the sheath. Many times, it is difficult to find the true lumen with a flush occlusion, and the operator is hesitant to press further for concern of jeopardizing the profunda (ie, deep femoral artery). As such, retrograde popliteal and/or tibial access should be obtained.
popliteal artery should be accessed at the popliteal fossa behind the knee by either extravascular ultrasound or angiographic visualization (Figure 3). Ultrasound-guided access requires the operator to be well versed in vascular ultrasound or to have a trained ultrasonographer available. Understanding angiographic access techniques is also essential when approaching complex cases, especially when extravascular ultrasound is inadequate and/or unavailable. Popliteal access can be obtained with the patient oriented in a supine or prone position. In the supine position, the ipsilateral leg is externally rotated and the knee is flexed (frog legged) to adequately view the popliteal fossa. The advantage of this approach is that a contralateral retrograde or antegrade CFA access can be well visualized. The disadvantage is that patients with orthopedic ailments are unable to adequately flex and rotate the leg, making it difficult to access the popliteal artery. Alternatively, the patient can be positioned in a prone position to allow direct visualization of the popliteal fossa. Direct visualization of the popliteal artery is easily observed with both extravascular ultrasound and/or by angiography. A digital subtraction angiogram is obtained from above by either a contralateral retrograde access site using a long sheath (at least 55 cm) or radial/brachial access.

Distal SFA access is considered in patients with chronic total occlusions of this segment, and the artery is lined by either calcium and/or stent such that the vessel can be visualized without contrast injection (Figure 4). For angiographic visualization, the camera is oriented in a medial oblique orientation (ie, left leg–right anterior oblique and right leg–left anterior oblique) and the artery is directly accessed through the thigh with an 18 G
needle, stiff glide wire, and stiff crossing catheter (eg, NaviCross).

**LESIONS OF THE TIBIAL ARTERIES**

The tibial arteries are also important to consider. The popliteal artery gives rise to the anterior tibial (AT) artery and the tibioperoneal (TP) trunk at the level of the inferior angle of the popliteal fossa. The posterior tibial (PT) and peroneal arteries arise from the TP trunk and reside in the deep posterior compartment of the lower leg, while the AT artery resides in the anterior compartment (Figure 5). Extravascular ultrasound-guided access has been shown to be safe and effective in peripheral arterial interventions. Extravascular ultrasound is easily used for access of the AT and PT arteries since they are superficial, especially in the distal third of the lower leg. However, the peroneal artery is a deep structure and often difficult to visualize by extravascular ultrasound.

Accessing the posterior tibial artery is often the most difficult tibial access. It tends to roll off the needle since it is not held in place by musculoligamentous structures. Angiographically, with a patient lying supine with the leg in a frog-leg position, the PT artery is accessed with a micropuncture needle from the medial aspect of the leg with the camera turned in a medial orientation such that the needle is perpendicular to the artery and parallel to the x-ray beam (Figure 6). The peroneal is the second most difficult tibial artery to access. Unlike the PT artery, the peroneal is held in place by the surrounding structures. The camera is positioned laterally to the lower leg to splay the tibia and fibula bones. The peroneal artery lies between these bones angiographically and is deep behind the intraosseous membrane. Tactile feedback from the micropuncture needle is used as a guide when advancing the needle toward the peroneal (Figure 7). A release of tension is noted when the needle punctures the intraosseous membrane, and another release of tension is noted when the peroneal artery is cannulated. Compared with the PT, the AT artery is often the easiest tibial artery to access. The AT is also easier to access than the peroneal due to the relatively superficial location of the AT and the surrounding musculoligamentous structures that hold it in place. Angiographic access is obtained with the patient lying in a supine position with toes pointed toward the ceiling. The camera is placed in AP with a slight cranial position when accessing the dorsalis pedis artery. As access is obtained more cranial, the camera should be rotated lateral to the leg and access again should be with the needle oriented perpendicular to the vessel and parallel to the x-ray beam.

**CONCLUSIONS**

CLI is associated with very high morbidity and mortality. Endovascular interventions are often the last resort before con-
sidering limb amputation. Furthermore, patients with CLI have complex multilevel calcific disease with multiple CTOs. These technical obstacles require interventionalists to be well-versed in a variety of access techniques to successfully treat the patient and improve the chances for a good outcome. Interventionists should be prepared to think outside the box when traditional pathways are unsuccessful.

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