

# Alternative Access for Tibial Intervention

Techniques for treating challenging lesions.

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Infrapopliteal endovascular intervention has become a first-line therapy for many patients with tibial occlusive disease. Although patients with claudication may have angiographic evidence of below-the-knee (BTK) disease, tibial intervention is uncommonly performed for this reason alone.<sup>1</sup> In contrast, tibial occlusive disease is common in patients with critical limb ischemia (CLI), and the vast majority of infrapopliteal interventions are performed for patients presenting with symptoms of CLI (ie, ischemic rest pain and tissue loss). Nondiabetic patients with CLI will frequently have diffuse, multisegment disease, including aortoiliac, femoropopliteal, and/or infrapopliteal disease, whereas the classic distribution of disease in diabetic CLI patients tends to be infrapopliteal.<sup>2</sup>

This pattern of disease is important with regard to procedure planning because BTK intervention poses challenges that are unique to this segment of the lower extremity. Heavy calcification and frequent occlusions are dealt with in all arterial segments. Combining these factors with the smaller diameter of the tibial vessels, fewer and more difficult retrograde options, and lesser success of existing technologies make tibial intervention a technical challenge—a challenge that demands optimization of all aspects of lower extremity intervention, from arterial access to lesion crossing to treatment to closure.<sup>3</sup> This article discusses the importance of arterial and lesion access and, specifically, a technique for pedal access.

Strategic revascularization to a specific area of the foot is the ideal situation when dealing with nonhealing ulceration; however, CLI patients and their anatomy are far from an ideal scenario. Historically, there has been a goal of inline, pulsatile flow to one vessel to relieve ischemic rest pain and heal tissue ulceration. Recently, however, there has been resurrection of the angiosome principle, as technical improvements have raised the bar for acute angiographic success.<sup>4</sup>

Although a full discussion of the angiosome principle is beyond the scope of this article, briefly, the angiosome concept states that a successful vessel-specific revascularization

should relieve or improve symptoms of CLI if those symptoms are within that vessel's angiosome.<sup>5</sup> Efforts to improve flow to this territory should be exhausted. Still, a single vessel with restored flow may be all that can be hoped for or accomplished, depending on anatomy and outflow.<sup>6,7</sup> In this scenario, the philosophy of at least one patent vessel to the foot may have to apply.

## ACCESS CONSIDERATIONS

Choice of initial arterial access for tibial intervention is largely a matter of physician preference and, in most situations, is primarily a choice between an ipsilateral/antegrade or a retrograde contralateral approach to the common femoral artery (CFA). Considerations consist of those related to the patient, the physician, and the infrastructure of the lab. Anatomic issues related to the patient include scarred groin, large panniculus, tight aortic bifurcation, etc. These factors are important for gaining arterial access but also have implications for arterial closure after the procedure.

Physician issues relate to experience with technique, familiarity with the use of ultrasound (US)-guided access, radiation exposure, and hand-dominance (left-handed vs right-handed). Lab infrastructure considerations include roadmapping capability, inventory (balloon/sheath working lengths, etc.), and room set-up (patient positioning on table, use/availability of slave monitors, etc.). There are advantages and disadvantages to both the antegrade/ipsilateral and retrograde contralateral approaches to the CFA. Table 1 outlines some of these advantages and disadvantages. Distal access (pedal, tibial) is gaining favor in BTK intervention, mostly in cases of failed antegrade recanalization, and almost always requires the use of either roadmapping and/or sterile US-guided access.

## PEDAL ACCESS

Direct distal vessel access may be necessary for endovascular intervention if successful antegrade treatment cannot be achieved.<sup>8</sup> Currently available technology, including dedicated CTO devices and reentry

**TABLE 1. ADVANTAGES AND DISADVANTAGES OF ANTEGRADE VERSUS RETROGRADE CONTRALATERAL FEMORAL ARTERY ACCESS**

Choice of Access	Advantages	Disadvantages
Antegrade/ipsilateral CFA access	<ul style="list-style-type: none"> <li>• Shorter working distance</li> <li>• Shorter working lengths of balloons, wires, etc.</li> <li>• Better pushability/torqueability<sup>a</sup></li> </ul>	<ul style="list-style-type: none"> <li>• May be difficult due to patient anatomic factors (obesity, large panniculus)</li> <li>• May have limited closure options</li> </ul>
Retrograde contralateral CFA access	<ul style="list-style-type: none"> <li>• “Usual” room setup (physician/technologist familiarity)</li> <li>• Ability to use vascular closure devices<sup>b</sup></li> <li>• Less operator radiation exposure, in general</li> </ul>	<ul style="list-style-type: none"> <li>• May be difficult due to patient anatomic factors (tight aortic bifurcation, previous aortobifemoral graft)</li> <li>• Longer working lengths/longer wire and balloon exchanges</li> <li>• Less pushability/torqueability<sup>a</sup></li> </ul>

<sup>a</sup>Subjective/theoretical.  
<sup>b</sup>Within usual indications/contraindications.

catheters, allows successful antegrade reconstruction in a majority of cases; however, familiarity with alternative access techniques (pedal/tibial) is essential in dealing with the CLI population, because these patients will need all options explored for revascularization.

In some instances, there may be an advantage to retrograde pedal access and recanalization of occlusions; many operators anecdotally report easier recanalization from a distal approach. The theory behind this relates to a more resistant, firm proximal cap that may result in more frequent subintimal guidewire passage from an antegrade approach, with inability to reenter the true lumen. In these situations, a double-balloon technique (from the antegrade and retrograde approach) has been described to disrupt the dissection membrane, allowing wire passage between the two false channels.<sup>8</sup>

Of course, recanalization from a distal/pedal approach does not ensure an intraluminal position; however, there is frequent technical success in crossing occlusions in this manner. Although many balloon sizes and stent sizes are now 4-F compatible, allowing percutaneous transluminal angioplasty (PTA)/stenting from below, some physicians prefer using distal access for assistance in the recanalization alone, while performing the actual intervention from above. Rendezvous procedures, whereby a combination of antegrade and pedal access is used to facilitate a successful intervention, can be helpful if the distal access vessel diameter is not of sufficient size to accommodate an interventional sheath.<sup>8-10</sup> If atherectomy is to be performed, these devices in general require larger access sheaths (typically 6 F) and, therefore, tend to be performed from the antegrade approach.

## INITIAL STRATEGY

In our experience, direct pedal access for recanalizing tibial occlusions is used in less than 10% of cases. To date, we

have not selected a direct pedal approach as the initial strategy and employ this technique only for failed antegrade attempts. It should be noted that using a pedal vessel that is also the target vessel poses difficulties related to the access itself, namely spasm, dissection, and acute occlusion. A successful complex retrograde recanalization complicated by any of these difficulties at the access site can diminish the technical success of the procedure. As with any arterial access, meticulous technique with regard to needle placement and guidewire passage is paramount.

Pharmacologically, routine anticoagulation, typically with heparin or bivalirudin, is a standard part of any tibial artery intervention. The use of glycoprotein IIb/IIIa inhibitors has been reported in combined antegrade/retrograde approaches.<sup>9</sup> Liberal use of vasodilators theoretically provides protection against local complications. No data are available to indicate a consensus regarding adjunctive pharmacologic therapy for BTK access and/or intervention.

## OUR TECHNIQUE

Patient positioning for pedal access depends on whether the dorsalis pedis (DP) or the posterior tibial (PT) artery is selected. There is usually some degree of external rotation at the hip in normal positioning on the angiography table. The ability to rotate the foot easily in order to make slight adjustments for patient comfort, as well as maintain ease of technical access, is imperative. Some physicians advocate the use of nitropaste to allow vasodilatation; we have used this method selectively. The entire foot is sterilely prepared and in our facility, in patients with an open wound, the foot is prepared twice. A sterile drape is then placed over the planned puncture site. Our preference is to use sterile US guidance with a linear 7- or 12-MHz transducer to identify the specific access site. Roadmapping can also be used; however, the image can quickly become useless with any significant patient motion or repositioning, there-

by requiring another roadmap, which uses additional contrast and is still subject to more motion. Vessel calcification can also be used as a landmark for puncture in certain cases. A 21-gauge needle is recommended due to small vessel size and the need for 0.014- or 0.018-inch wires. Any low-profile catheter can be used to safely gain enough pur-

chase into the distal artery to facilitate retrograde recanalization. Sheath access is optional depending on whether intervention is planned from the access site. Sheath size selection is dependent on the native vessel diameter.

Once adequate purchase is achieved, guidewire selection and technique is essentially at the discretion of the



**Figure 1.** A 75-year-old man with a nonhealing ulcer. Initial angiogram demonstrating occlusion of the left anterior tibial artery (AT) and tibioperoneal trunk with reconstitution of proximal peroneal artery and faint filling of the proximal PT artery (A). Reconstitution of the distal AT via peroneal collaterals, patent into the left foot via DP artery (B). Failed antegrade recanalization. Note subintimal staining and extravasation distally (C). After coil embolization to seal subintimal tract, access achieved into the distal AT at the level of the ankle, with 0.014-inch guidewire placement (D). Wire is snared from above and externalized from the antegrade sheath to gain “through and through” access (E). PTA of AT performed from antegrade access (F). Final angiogram demonstrating brisk antegrade flow through the AT with smooth, consistent luminal diameter (G). Distal images show consistent, in-line flow into the foot via the DP. Note mild stenosis at puncture site, likely representing spasm (H). (Case courtesy of John H. Rundback, MD.)

physician. Numerous wires have been engineered by many companies to help negotiate stubborn tibial lesions. Access to several different types of wires is strongly recommended, because predicting which wire might be successful is fruitless. Still, most physicians will have a starter set and an array of go-to wires that have likely delivered success previously and therefore provide a measure of familiarity. Exchange length (300 cm) wires are recommended if the case is planned as an antegrade intervention because this will allow snaring of the wire from above, while maintaining a workable length of the wire from either end.

From a technical standpoint, retrograde tibial recanalization is quite similar, if not identical to antegrade techniques, with perhaps a few exceptions. Although intraluminal position may be desirable, it is in fact unpredictable, and in long lesions, it is likely that the guidewire alternates between subintimal and intraluminal positions. Specific BTK subintimal techniques have been described with procedural success and promising short-term outcomes. Because reentry devices are difficult to use in the infrapopliteal segment, meticulous technique can help avoid the creation of false passages. Avoiding an extravascular position is obviously critical.

Once the lesion has been successfully crossed from below, if the strategy is to perform the intervention from above, the guidewire can be snared and externalized through the antegrade sheath. This creates the “vascular floss” or “through-and-through” access situation. The low-profile catheter that was placed initially from below is then retracted to a position below the distal margin of the lesion but still within the vessel. A second low-profile catheter is then advanced over the wire from above, placing it well below the distal margin of the lesion, to where the two catheters are now tip to tip. Care should be taken not to advance the catheter out through the arterial puncture site. (Note: advancing the catheter through the occlusion can be difficult sometimes, and occasionally, a low-profile balloon can be placed [from above or below] to dilate the problem segment and enable easy exchange thereafter.)

At this point, the initial wire is removed completely by pulling it out through the distal puncture site (because there is now antegrade access across the lesion), leaving the first catheter still in place at the puncture site. A new guidewire is then placed through the proximal catheter and advanced as far distally as necessary. After securing optimal guidewire position from above, the planned intervention can be carried out as usual, with the full menu of options now available, as if there had been a successful antegrade recanalization (Figure 1A through 1H).

There are many variations on this theme, and we have certainly employed some of them.<sup>9-11</sup> As an example, we

have used the retrograde recanalization wire (300-cm length) once it has been externalized as the working wire using monorail balloons and stents because there is access across the lesion, and these rapid-exchange devices only require minimal working length.

## OUR PREFERENCES

Our experience with tibial intervention has taken us through a diverse inventory of small-vessel devices. A comprehensive list of all wires/sheaths/balloons/stents used in these interventions cannot be included here due to space limitations; however, it can be stated that for practicing interventionists, nearly all medical device companies involved in the endovascular space understand the significance of CLI, recognize the market potential, have made efforts to improve BTK technologies, and largely have successfully delivered. More research needs to occur, and newer developments are likely to be forthcoming (drug-coated balloons, bioabsorbable stents, etc.).

Although some frequently used devices have an US Food and Drug Administration indication for infrapopliteal intervention, many do not, and therefore comfort with off-label use and physician preference are real drivers with regard to inventory. Along these lines, development of specific pedal access tools may be of particular importance as this technique further matures.

Our own inventory has gone through many changes over the years as developments occur, and it is admittedly somewhat of a moving target. It is possible that by the time this article is printed, we may have changed our preferences; therein lies the problem with such a dynamic space. With that said, an outline of our selections follows.

Regarding arterial puncture, a micropuncture system (Micro-Stick, Medcomp/Medical Components, Inc., Harleysville, PA) is used, with initially placing a short nitinol 0.018-inch wire strictly for gaining access. Just the inner 3-F dilator is placed to minimize vessel trauma. Our guidewire preference is then a 300-cm, 0.014-inch wire (ThruWay or Journey, Boston Scientific Corporation, Natick, MA, or Hi-Torque Balanced MiddleWeight, Abbott Vascular, Santa Clara, CA) for initial recanalization attempts. A modified exchange-type catheter is then placed for support and advancement through the occluded segment.

Our current preference is to simply cut a 0.014- or 0.018-inch QuickCross catheter (Spectranetics, Colorado Springs, CO) to an appropriate length. The catheter should be long enough to be able to advance across the occlusion from below but should be short enough to be manageable as well. Our experience has shown that a length of 50 to 70 cm is capable of accomplishing this in the tibial segment. If there is a resistant lesion requiring more “muscle,” a weighted-tip wire (Approach, Cook Medical, Bloomington,



IN) is sometimes employed, ranging anywhere from 6- to 18-g tip load.

After recanalization, the wire is snared (6- to 10-mm En Snare, Merit Medical Systems, Inc., South Jordan, UT, or 5-mm Amplatz GooseNeck snare, Covidien, Mansfield, MA), typically at the level of the superficial femoral artery or CFA. A second 0.014- or 0.018-inch QuickCross is then advanced over the snared wire to the distal tibial vessel, and a new ThruWay or Journey wire is used as the working wire to perform the intervention.

## EXIT STRATEGY

The decision regarding when to remove access from the tibial vessel depends on whether a wire was left in place alone or if a sheath was placed to perform the intervention. If only a small catheter or wire was placed from below, they can be removed at any time after the recanalization, with manual pressure applied for hemostasis. A moderate, nonocclusive hold is preferred. Our strategy includes placing the antegrade wire distal to the pedal puncture site, if possible, to maintain access across it, in the event a balloon needs to be inflated or other bailout measures performed.

Our experience has also shown that the distal wire/microcatheter can be removed even before the intervention because there is still relatively low pressure in this segment, as the revascularization has not been completed. Certainly, if a sheath was placed for intervention, this is removed postintervention with manual compression for hemostasis. Others have described withdrawal of distal access after completion of the intervention, manual compression of the pedal access during the intervention, and balloon inflation across the puncture site for hemostasis.<sup>12</sup> Vascular closure devices are not specifically US Food and Drug Administration approved in tibial artery access, and their delivery size effectively precludes their use in the pedal arteries.

## COMPLICATIONS

It should be noted that it appears that vessel perforation or extravascular wire position is more common in BTK intervention than in the femoropopliteal segment. The sequelae of this can be relatively benign but can result in a compartment syndrome. Careful postprocedural monitoring of pulses, motor, and sensory function is advised. Treatment of intraprocedural vessel rupture consists of prolonged balloon inflation, covered stent placement, and even coil embolization (Rundback J, personal communication, September 2011).

Complications specifically related to access are uncommon but can jeopardize the success of the intervention and include bleeding/hematoma, dissection, and access

vessel thrombosis/occlusion. The latter has potentially devastating clinical consequences, particularly if this is the only patent pedal vessel. Normally, complete patient recovery can be expected typically within 4 to 6 hours, again primarily dictated by sheath versus wire-only tibial access. Because many of these patients have comorbidities, overnight observation may be indicated, particularly with complex interventions and/or multiple access sites.

## CONCLUSION

Personal experience with pedal and tibial access techniques has proven beneficial for patients in our practice requiring endovascular tibial intervention for CLI. Our experience is similar to other physicians in that we incorporate them in a minority of cases due to fairly predictable success using standard antegrade techniques, but the pedal approach is invaluable in certain situations. Although there are many similarities with interventions in other arterial beds, the tibioperoneal segment can be quite challenging and requires a complete strategic plan incorporating choice of initial and possible secondary arterial access, as well as advanced techniques for lesion access and crossing. The advantage provided by these tactical choices can turn failure into success, which can translate into limb salvage and survival. ■

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