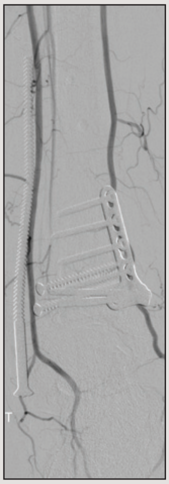
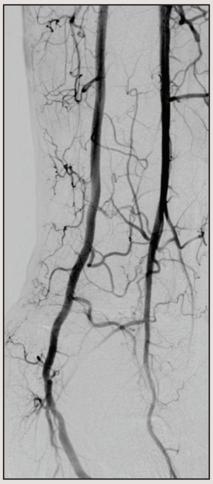
Supplement to

Sponsored by Cook Medical

Endovascular TODAY

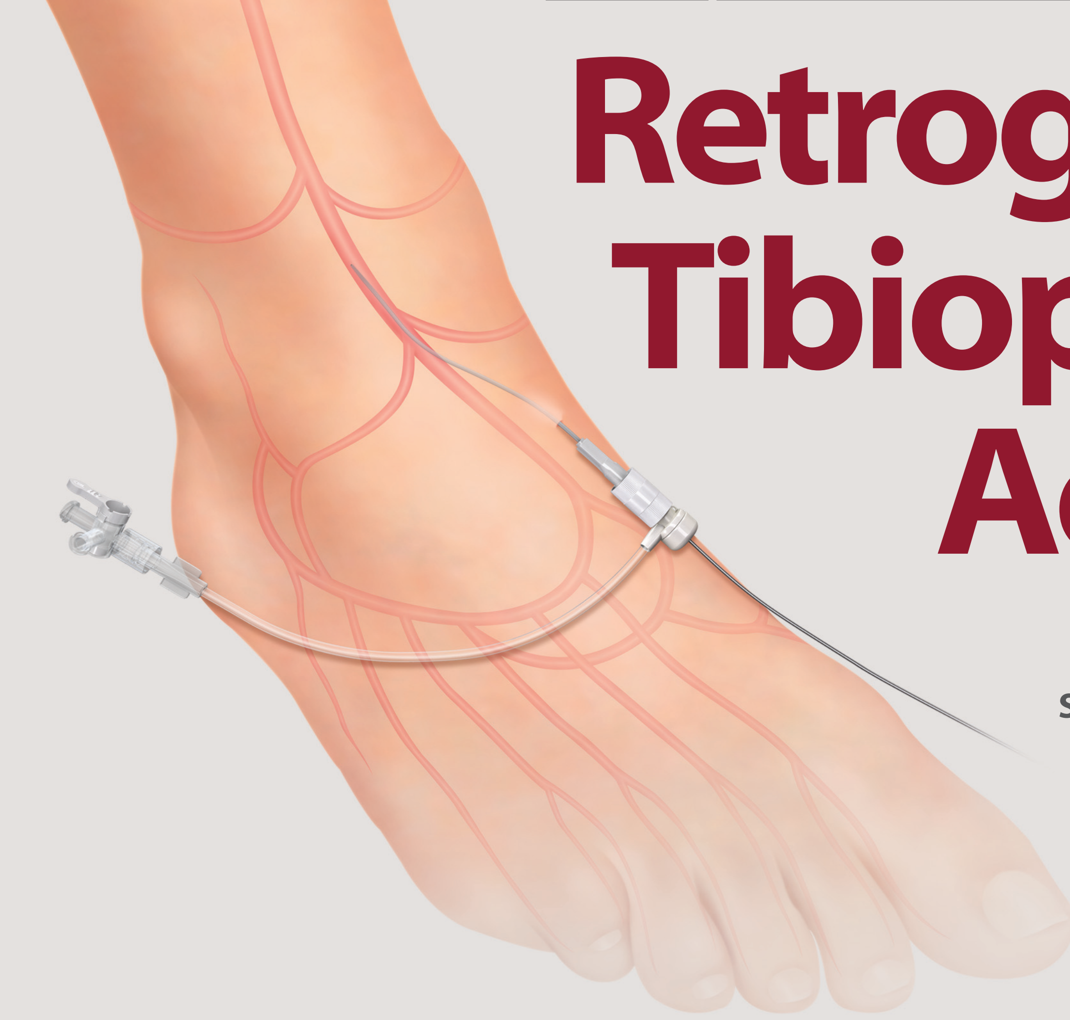
January 2012





Retrograde Tibiopedal Access

A look at patient selection, anatomy, and the ideal tools for this emerging access option.



Retrograde Tibiopedal Access

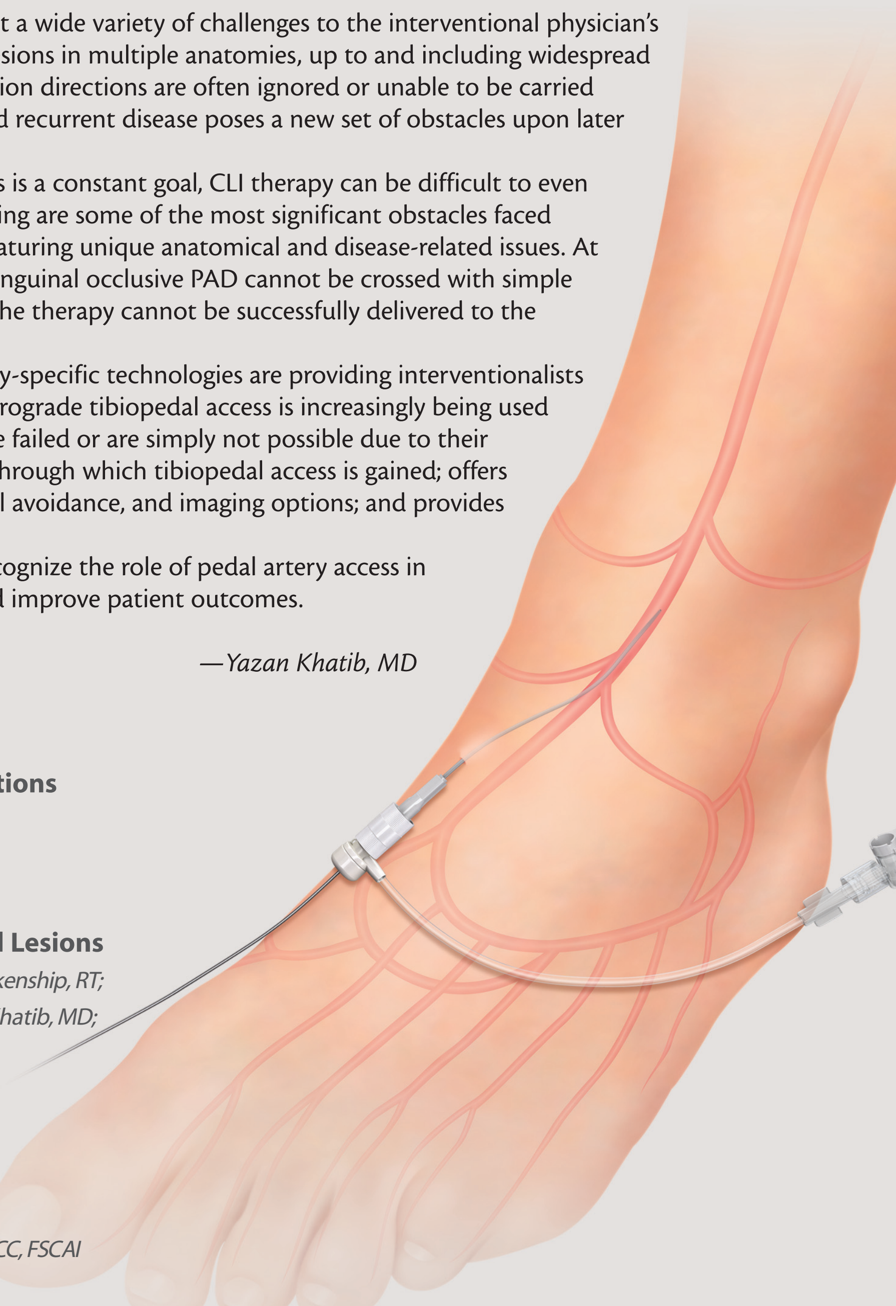
Critical limb ischemia (CLI) patients present a wide variety of challenges to the interventional physician's ability to treat their disease. Many have lesions in multiple anatomies, up to and including widespread cardiovascular disease. Lifestyle modification directions are often ignored or unable to be carried out due to the very nature of the symptoms, and recurrent disease poses a new set of obstacles upon later presentations.

Although sustaining long-term, durable results is a constant goal, CLI therapy can be difficult to even initiate. Target vessel and lesion access and crossing are some of the most significant obstacles faced when treating this population, with each case featuring unique anatomical and disease-related issues. At least 10% to 15% of patients with complex infrainguinal occlusive PAD cannot be crossed with simple antegrade or retrograde femoral approaches. If the therapy cannot be successfully delivered to the lesion, there is simply no chance of limb salvage.

Fortunately, emerging techniques and anatomy-specific technologies are providing interventionalists with new pathways via alternate access sites. Retrograde tibiopedal access is increasingly being used for patients in whom other access attempts have failed or are simply not possible due to their disease. This supplement looks at the anatomy through which tibiopedal access is gained; offers tips on patient selection, procedural steps, pitfall avoidance, and imaging options; and provides illustrative cases employing this technique.

We hope this supplement will help readers recognize the role of pedal artery access in revascularizing difficult tibioperoneal lesions and improve patient outcomes.

—Yazan Khatib, MD



CONTENTS

3 Anatomy of the Pedal Arch and Implications for Tibiopedal Access
By Albeir Y. Mousa, MD; Robert S. Dieter, MD, DVT; and Aravinda Nanjundappa, MD, RVT

6 Transpedal Artery Access for Tibiopedal Lesions
By Aravinda Nanjundappa, MD, RVT; Brandon Blankenship, RT; Phani Kathari, MD; Nelson L. Bernardo, MD; Yazan Khatib, MD; Albeir Y. Mousa, MD; Robert S. Dieter, MD, DVT; and Jihad A. Mustapha, MD, FACC, FSCAI

9 Transpedal Arterial Access in Practice
By Aravinda Nanjundappa, MD, DVT; Robert S. Dieter, MD, DVT; Nelson L. Bernardo, MD; Albeir Y. Mousa, MD; and Jihad A. Mustapha, MD, FACC, FSCAI

Case images on cover courtesy of Aravinda Nanjundappa, MD, RVT

Anatomy of the Pedal Arch and Implications for Tibiopedal Access

An overview of anatomical characteristics and access options for challenging CLI cases.

BY ALBEIR Y. MOUSA, MD; ROBERT S. DIETER, MD, DVT; AND ARAVINDA NANJUNDAPPA, MD, RVT

A strong understanding of pedal arch anatomy is imperative for physicians performing lower extremity revascularization. It is especially important that this anatomy be carefully evaluated in all cases of critical limb ischemia (CLI). Morphological and functional determination of pedal arch vessel patency has an important role in planning and performing limb salvage procedures in patients with CLI.[1,2] There is usually a dominant blood supply between the two main arteries supplying the foot: the anterior tibial and posterior tibial arteries.

ANTERIOR CIRCULATION

Normally, the anterior tibial artery, which is the first branch of the popliteal artery, passes between the tibialis anterior and extensor hallucis longus muscles. At the level of the ankle, the anterior tibial artery crosses under the extensor retinaculum just lateral to the tendon of the extensor hallucis longus muscle. As it reaches the dorsum of the foot, the vessel's name changes to the dorsalis pedis artery. This artery ends at the first metatarsal space by branching to form the arcuate artery, which will supply branches to all toes and then turn sharply to join the perforator branches of the posterior plantar circulation and the pedal arch.

POSTERIOR CIRCULATION

The posterior tibial artery begins as one of the two branches of the tibioperoneal trunk. As it traverses posterior to the medial malleolus, it becomes the common plantar artery in the retromalleolar space. Then, the common plantar artery divides into medial and lateral arteries. The lateral plantar artery traverses along the lateral aspect of the plantar surface of the forefoot. After following a curvy pathway, it joins the anterior circulation by communicating with the dorsalis pedal artery at the first plantar space. The medial plantar artery crosses directly along the medial aspect of the plantar surface of the forefoot and ends at the first metatarsal space, where it becomes the hallux digital arteries.[3]

PEDAL ARCH

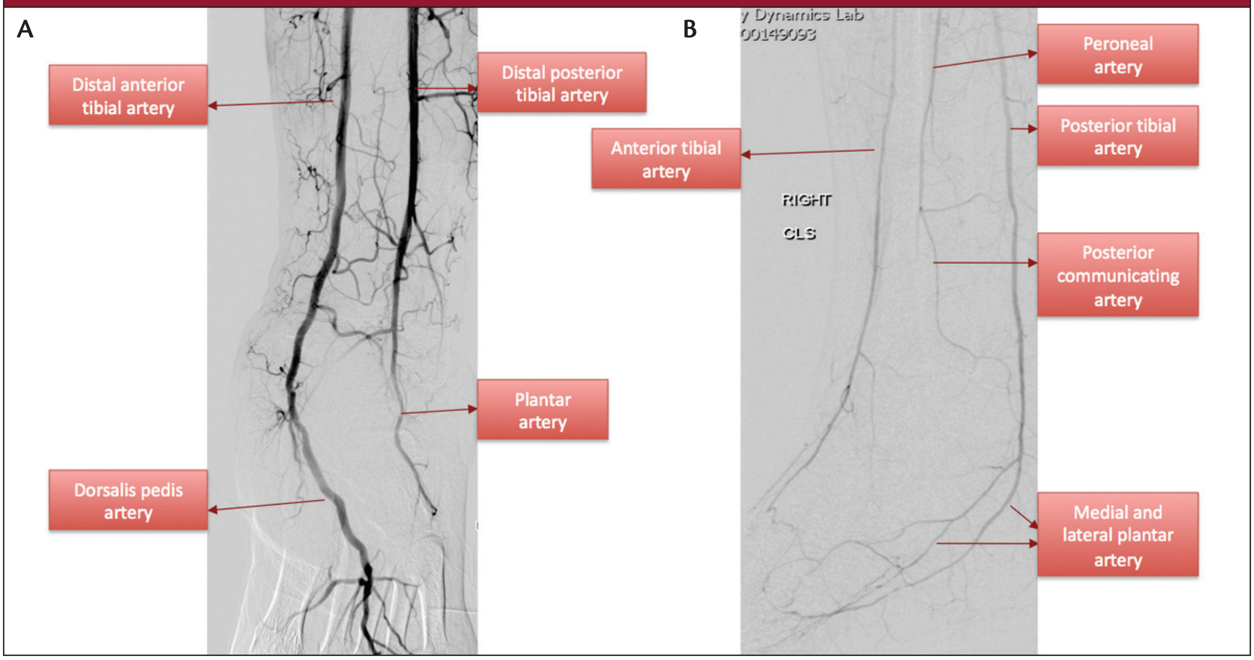
Normally, the area between the anterior and posterior circulation will form the pedal arcade. This is primarily constituted by the deep perforating branches of the dorsal artery of the foot and the lateral plantar arteries. It is crucial to understand the patency of the pedal arch for proper preoperative planning of pedal vessel revascularization. The anastomosis between the main pedal arch vessels (namely the dorsal and lateral plantar arteries) can be outlined well in oblique or lateral views seen on conventional angiography. This arcade is the stem supply for all distal forefoot circulation.

DIAGNOSIS

Optimal evaluation of the pedal arch is needed in patients with foot ulcers or ischemic changes. Although the gold standard means of evaluation may still be angiography, this option carries the risk of groin hematoma and contrast nephropathy, as well as added expense. Duplex ultrasound has been evaluated as a valid tool to examine pedal arch vessels,[4] and some have proposed the use of an 8-MHz Doppler probe to evaluate the pedal arch. Using this method, the probe should be placed in the first metatarsal space. Presence of a Doppler signal can be taken as evidence of a patent pedal arch. Digital pressure can also be applied over each tibial artery at the malleolar level to determine each vessel's communication with the pedal arch.

Computed tomographic angiography and magnetic resonance angiography are very sensitive tools that can provide significant information on the nature of the pedal vessel disease. In a recent study,[5] three-dimensional magnetic resonance angiography of distal calf and pedal vasculature in CLI was shown to be superior to conventional selective digital subtraction angiography and high-resolution duplex ultrasound. Although duplex ultrasound is a sensitive tool for tibial vessel evaluation, visualization of the peroneal artery may be difficult, and a certain level of expertise will be required. Once the tibial vessel is visualized, ultrasound imaging is

ANATOMY OF TIBIOPEDAL VESSELS AND PEDAL ARCH



not inferior to results obtained via computed tomographic angiography.[6]

APPLYING TIBIOPEDAL ACCESS IN LIMB SALVAGE

The traditional limb salvage treatment for CLI patients with rest pain or tissue loss (Rutherford 4–6) is surgical bypass.[7] However, the advent of minimally invasive endovascular therapy has offered comparable results in appropriately selected patients,[8] and the ongoing improvements in technology continue to offer more options for successful treatment of more complex disease presentations. The first steps in delivering endovascular therapy are to obtain access and traverse the lesion. When conventional approaches (antegrade or contralateral retrograde) fail, a tibial vessel approach may offer a valid alternative route to cross the lesion.

Limb salvage continues to be a challenge when treating patients in whom the traditional ipsilateral antegrade or contralateral retrograde approach (up-and-over technique) fails. In these cases, pedal access approaches utilizing the dorsalis pedis, posterior tibial, or even peroneal arteries can offer considerable advantages (Table 1). These approaches may offer a better chance of crossing long tibial occlusive segments.

INTERVENTIONAL CHALLENGES AND TECHNICAL TIPS

The size of tibial vessels poses the biggest challenge to the vascular specialist (Table 2). Access via ultrasound guidance is highly recommended because missed access or multiple attempts may contribute to significant bleeding, nerve compression, or even compartment syndrome. Due to the smaller vessel size, the use of smaller sheaths and smaller catheters based on 0.014- or 0.018-inch systems is recommended.

Patient position can be problematic, but pedal access can usually be accomplished with the patient in the supine position. When attempting to use the dorsalis pedis approach, the foot should be placed in the dorsiflexion position; supination of the foot may be required in cases using a posterior tibial artery approach.

Once access is achieved, heparin should be administered according to protocol. We have been using nitroglycerin as well as calcium channel blockers selectively in some cases, namely those in which vasospasm is occurring. Our anecdotal experience is that this combination of medications may be particularly beneficial in heavy smokers.

PUBLISHED EXPERIENCES

The feasibility of this approach has been evaluated in case reports[9] and series. Fusaro et al have indicated the feasibility of retrograde pedal artery access for below-the-knee percutaneous revascularization.[10] Kawarada et al have reported feasibility of the transpedal approach to cross occluded dorsalis pedis and paramalleolar posterior tibial arteries, which are considered a rare atherosclerotic pattern in the crural arteries.[11] The investigators achieved complete infrapopliteal recanalization and wound healing.

In a recent study by Walker,[12] pedal access was attempted after the antegrade route was deemed unsuccessful in 273 patients with CLI (Rutherford 4–6). Patient ages ranged from 42 to 90 years, 32% of patients were diabetic, and 59% were smokers. All patients had occlusive lesions. Pedal access was successful in 96% of patients—54% via anterior tibial approach, 45% via pos-

TABLE 1. ADVANTAGES OF TIBIOPEDAL ACCESS
• Small diameter of tibial vessels may help to increase the pushability of catheter or wire through occlusion
• Less likelihood of entering sidebranch or collateral
• The most difficult portion of the occlusion is the proximal segment; the distal portion is often less difficult
• In cases of occluded short segment tibial or popliteal arteries, the pedal approach may offer a shorter arterial segment to cross with balloons, catheters, and stents than traditional ipsilateral or contralateral approaches
• Useful in cases in which vessel size precludes use of embolic protection devices during antegrade or retrograde femoral approaches
• May have safety potential in obese patients in whom a groin approach may not be feasible
• May have a role in patients having a hostile or infected groin in which conventional intervention is not feasible

TABLE 2. POTENTIAL DISADVANTAGES OF TIBIOPEDAL ACCESS
• Small-diameter vessels are prone to spasm and dissection
• Vessels are often calcified
• Approach near the ankle may cause significant difficulty in sheath passage because of the sharp angulation

terior tibial approach, and < 1% via peroneal access. The investigators reported no access failures in vessels with a diameter > 1.5 mm by quantitative angiograms. In 93% of patients with successful pedal access, microcatheters, small-profile balloons, and 0.014- or 0.018-inch systems were used with definitive therapy accomplished from femoral access.

In 7% of patients, 4-F sheaths were placed initially in pedal vessels and upgraded to 6-F sheaths for definitive therapy. Technical success as defined by crossing the lesions was achieved in 93% of patients. In this study, atherectomy devices were used in 97% of patients followed by prolonged balloon inflation over a 3-minute period. Adjunctive stents were used in 58% of SFA occlusions and 13% of popliteal occlusions. Antegrade flow was restored in 99% of patients. The author noted a decrease in level of amputation after revascularization; 49 out of the 57 patients who initially presented with advanced gangrenous changes underwent minor amputation (digits). Two of the 112 patients with nonhealing ulcers required reintervention to maximize wound healing.

CONCLUSION

Pedal access is a relatively recent innovation of vascular intervention. It is a feasible approach with potential immediate benefits that may increase utilization of this approach. There is a learning curve involved with this interventional approach, and we will continue to gain further understanding of its ideal uses in the time to come. ■

Albeir Y. Mousa, MD, is Assistant Professor of Surgery at Robert C. Byrd Health Sciences Center, West Virginia University in Charleston, West Virginia. He has disclosed that he has no financial interests related to this article. Dr. Mousa may be reached at amousa@hsc.wvu.edu.

Robert S. Dieter, MD, RVT, is Associate Professor of Vascular & Endovascular Medicine and Interventional Cardiology at Loyola University Medical Center in Chicago; and Director of Vascular Medicine and Peripheral Vascular Interventions, Medical Director of the Cardiovascular Collaborative, and Associate Chief of Cardiology at the Edward Hines, Jr. VA Hospital in Hines, Illinois. He has disclosed that he has no financial interests related to this article. Dr. Dieter may be reached at rdieter@lumc.edu.

Aravinda Nanjundappa, MD, RVT, is Associate Professor of Medicine and Surgery, Division of Vascular Surgery at Robert C. Byrd Health Sciences Center, West Virginia University in Charleston, West Virginia. He has disclosed that he is a paid consultant to Cook Medical.

1. Bartos J, Mayzlik J, Skotnicova S, et al. Significance of the pedal arch for patency of femoropopliteal bypasses [in Czech]. Rozhl Chir. 1990;69:287-293.
2. Dardik H, Ibrahim IM, Sussman B, et al. Morphologic structure of the pedal arch and its relationship to patency of crural vascular reconstruction. Surg Gynecol Obstet. 1981;152:645-648.
3. Chomel S, Doucek P, Moulin P, et al. Contrast-enhanced MR angiography of the foot: anatomy and clinical application in patients with diabetes. Am J Roentgen. 2004;182:1435-1442.
4. Roedersheimer LR, Feins R, Green RM. Doppler evaluation of the pedal arch. Am J Surg. 1981;142:601-604.
5. Langer S, Krämer N, Mommertz G, et al. Unmasking pedal arteries in patients with critical ischemia using time-resolved contrast-enhanced 3D MRA. J Vasc Surg. 2009;49:1196-1202.
6. Grassbaugh JA, Nelson PR, Rzucidlo EM, et al. Blinded comparison of preoperative duplex ultrasound scanning and contrast arteriography for planning revascularization at the level of the tibia. J Vasc Surg. 2003;37:1186-1190.
7. Rutherford RB. Evaluation of a proposed standard reporting system for preoperative angiograms in infrainguinal bypass procedures: angiographic correlates of measured runoff resistance. J Vasc Surg. 1988;7:577.
8. DeRubertis BG, Faries PL, McKinsey JF, et al. Shifting paradigms in the treatment of lower extremity vascular disease: a report of 1000 percutaneous interventions. Ann Surg. 2007;246:415-422; discussion 422-424.
9. Downer J, Uberoi R. Percutaneous retrograde tibial access in the endovascular treatment of acute limb ischaemia: a case report. Eur J Vasc Endovasc Surg. 2007;34:350-352.
10. Fusaro M, Tashani A, Mollichelli N, et al. Retrograde pedal artery access for below-the-knee percutaneous revascularisation. J Cardiovasc Med (Hagerstown). 2007;8:216-218.
11. Kawarada O, Yokoi Y, Sekii H, et al. Retrograde crossing through the pedal arch for totally occluded tibial artery. J Interv Cardiol. 2008;21:342-334.
12. Walker C. Durability of PTAs using pedal artery approaches. Paper presented at: 37th Annual VEITHsymposium; November 18, 2010; New York City, NY.

Transpedal Artery Access for Tibiopedal Lesions

Tools and techniques for achieving revascularization.

BY ARAVINDA NANJUNDAPPA, MD, RVT; BRANDON BLANKENSHIP, RT; PHANI KATHARI, MD; NELSON L. BERNARDO, MD; YAZAN KHATIB, MD; ALBEIR Y. MOUSA, MD; ROBERT S. DIETER, MD, DVT; AND JIHAD A. MUSTAPHA, MD, FACC, FSCAI

Transpedal artery access to revascularize complex tibiopedal lesions in patients with critical limb ischemia (CLI) has gained momentum in recent years.[1] Transpedal access is vital in failed retrograde and antegrade femoral access for limb salvage.[2] Occasionally, morbidly obese patients with claudication due to femoropopliteal segment occlusions may require transpedal access for revascularization. This article discusses the role of transpedal access, the use of duplex ultrasound for access, and the role of 4-F pedal access kits.

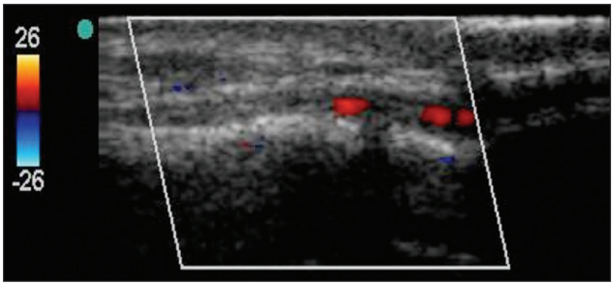


Figure 1. Ultrasound imaging of the dorsalis pedis artery.

BACKGROUND

CLI needs adequate revascularization to achieve a straight-line flow to the foot.[3] Partial revascularization of iliac or femoropopliteal arteries alone is usually insufficient to heal advanced leg ulcers or gangrene. Antegrade and retrograde femoral access have a failure rate of 15% to 20% when crossing difficult tibiopedal occlusions.[2] Retrograde femoral artery access is an easy and commonly used method of access but has some disadvantages when crossing tibiopedal lesions.[4] For example, few balloons and catheters are available for reaching distal tibiopedal lesions. Also, the crossing wire loses the ability to carry torque, which affects pushability, and there is an increased chance of vessel dissection and failure to revascularize. Antegrade femoral access may increase the ability to cross tibiopedal lesions due to the availability of catheters, wires, and adequate support for catheter crossing. However, antegrade femoral access requires operator experience (at least five cases to be proficient) because the risk of multiple punctures resulting in hematoma is high. Antegrade puncture may also cause difficulty in access management, especially in obese patients.

TECHNIQUE

Transpedal access also requires operator experience (at least 10 cases to be proficient), but the technique can have a short learning curve. Using duplex ultrasound can be helpful in achieving access. An alternative approach to transpedal access includes roadmapping or image overlay. However, this method can be difficult if the patient moves or if there is table movement, and it also requires the use of additional contrast. This method requires operator expertise because the puncture must be made at a 90º angle to the flow. Exposure of fingers to radiation is also a concern here.

Duplex Ultrasound to Access the Pedal Artery

Using handheld duplex ultrasound can help locate the tibiopedal vessels. The pedal vessels are usually accessed under local anesthesia with a 4- or 5-F microaccess needle. Based on angiosome distribution, the most commonly accessed pedal arteries are the dorsalis pedis artery, followed by the posterior tibial artery and peroneal artery. However, the peroneal artery's course lies on the interosseous ligament, and manual pressure for hemostasis can prove cumbersome.

Operator familiarity with duplex ultrasound is important, but the learning curve can be short, especially for vascular interventionalists who are already familiar with the use of duplex ultrasound for femoral arterial and venous access. A handheld duplex ultrasound can provide an image of the dorsalis pedis artery in both short and long axis (Figure 1), the long axis view is the preferred approach and short axis is easy to puncture with the needle. A novice to pedal artery access should seek assistance from ultrasound technicians to image and access the pedal artery. However, after success with a few cases, the operator should be able to use the duplex independently. An attempt must be made to achieve access with the first puncture to prevent spasm, and if the puncture is through and through, slow withdrawal of the needle will facilitate

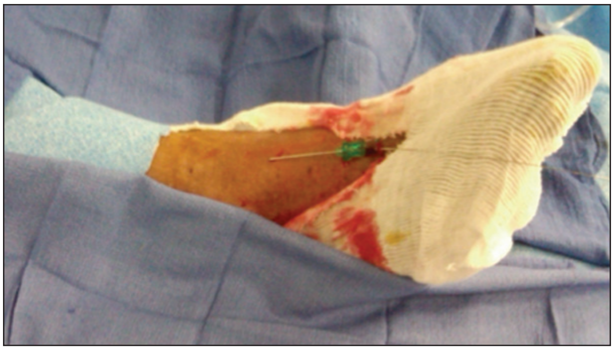


Figure 2. A 4-F Micropuncture® needle (Cook Medical, Bloomington, IN) in the dorsalis pedis artery.

access with a Micropuncture® wire guide. The access wire should be advanced only to the occluded segment of the pedal artery to prevent vessel dissection. Dilator placement over the wire will facilitate placement of a sheath.

Cook Medical provides a 4-F pedal access kit with a sheath that has a side arm for injecting fluids and contrast (Figures 2 and 3). The dedicated Micropuncture® Pedal Access Set consists of a 21-gage, 4-cm echogenic needle; a 7-cm Micropuncture® introducer engineered to increase control while gaining retrograde infrapopliteal access; and a 0.018-inch nitinol wire guide and hemostasis valve. This Check-Flo® hemostasis valve attaches directly to the Micropuncture introducer, allowing it to be used as an interventional introducer with a 2.9-F inner diameter.

We advise the use of nitroglycerin, a small dose of heparin, and sometimes verapamil to prevent vessel spasm and clotting. A 0.014- to 0.035-inch wire can be advanced via this sheath. Additional support can be achieved with a 0.018-inch CXI™ support catheter (Cook Medical) This method will allow crossing of lesions and subsequent insertion of the wire into a sheath from femoral access or the snaring of the pedal wire from the top. Further delivery of balloons and stents can be performed via the femoral approach. The pedal sheath and the catheters can be removed and manual pressure held (Figure 4).

Another option is the placement of 4-, 5-, or 6-F sheaths in patients with adequate-caliber pedal arteries. The dedicated Micropuncture® Pedal Access Set is available in 4- and 5-F outer diameters; physicians sometimes use 5- or 6-F sheaths (inner diameter) if the vessel is large enough. The 5- or 6-F sheath will allow delivery of balloons and stents to the lesion. Use of a large sheath will require sheath removal when the activated clotting time is within normal limits. Occasionally, use of a radial band in the foot to achieve hemostasis can be helpful. A large-caliber sheath may cause vessel occlusion.

Total Occlusion of the Tibiopedal Lesions

It can be helpful to use a 0.014-inch coronary wire after gaining pedal access. Total occlusion wires such as MiracleBros, Confianza (Asahi Intecc Co., Ltd., Nagoya, Japan), or Cook Medical wires are usually the first choice. In some cases, hydrophilic-coated wires such as the ChoICE PT Extra Support (Boston Scientific Corporation, Natick, MA), Pilot 50 (Abbott Vascular, Santa Clara, CA), or Fielder XT (Asahi Intecc) can also be helpful. Some operators have described the use of a 0.035-inch Glidewire (Terumo Interventional Systems, Somerset, NJ) to cross tibiopedal occlusions from the pedal approach. Use of support catheters in a sheathless "bareback" fashion is useful in difficult cases. Here, a 0.018-inch CXI™ support catheter is placed inside a 0.035-inch catheter and is used in a telescoping fashion. Any 0.014- or 0.018-inch wires can be used. An alternative is to use a sheathless 0.014-inch balloon via pedal access over a 0.014-inch wire to cross the tibiopedal vessels. Balloon-angioplasty–supported wire advancement may be needed to minimize friction in these occlusions. The downside of this technique is that a larger-profile balloon will be withdrawn from the pedal vessels and may predispose to vessel trauma.

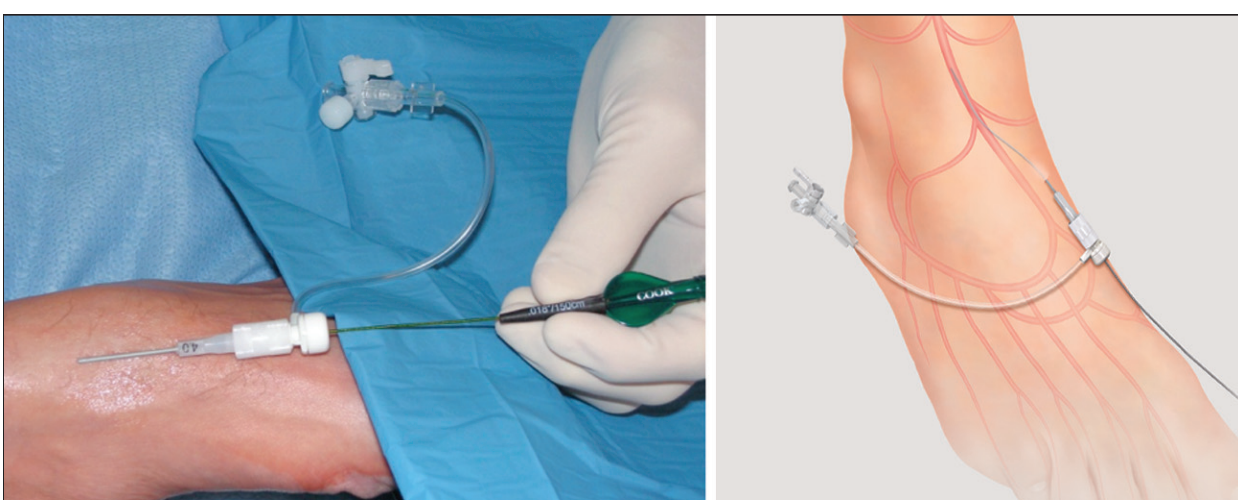


Figure 3. Dedicated Micropuncture® Pedal Access Set in the dorsalis pedis artery.

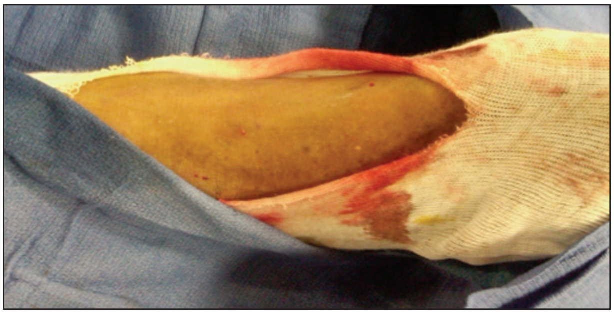


Figure 4. Successful hemostasis of the dorsalis pedis artery after manual compression.

Pedal Access for Popliteal and Distal Superficial Femoral Artery Occlusions

We have performed pedal access for crossing distal femoral and popliteal lesions in morbidly obese patients. In such patients, the body habitus may be a nidus for vascular access complications when femoral antegrade or retrograde approaches are used. The pedal approach and delivery of a 5-mm balloon via a 5-F sheath has facilitated plain old balloon angioplasty and successful recanalization of occluded femoropopliteal lesions.

Existing Clinical Data

We searched the literature on CLI, and a total of fewer than 400 cases of pedal artery access interventions have been published. No prospective randomized clinical trials comparing antegrade/retrograde femoral versus retrograde pedal access have been published. A registry studying retrograde pedal access and subsequent prospective clinical trials are anticipated. The technique continues to evolve, and the number of procedures performed is increasing.

The Evolving Role of Pedal Artery Access in the Management of CLI

Retrograde pedal artery access can increase the success of recanalization of occluded tibiopedal occlusions. Transpedal access is especially beneficial in patients who have had a failed retrograde or antegrade femoral attempt at recanalization of the occluded tibiopedal vessels. The interventionalist needs to be familiar with this approach, which can be an important rescue procedure, to increase limb salvage rates. We believe familiarity with pedal access and lesion crossing will increase the number of procedures performed, and in the future, interventionalists may adopt the pedal-first approach in conjunction with antegrade access. There is an increasing need for a dedicated pedal sheath to accommodate delivery of catheters, balloons, and stents, as well as a need for the development of dedicated short-length wires, balloons, and stents to use in the approach.

CONCLUSION

The use of transpedal access to achieve a high success rate for limb salvage is clearly an innovative technique. Case selection, operator experience, and appropriate technique are essential for optimal clinical and procedural success. We hope a wide acceptance and adoption of this approach will improve clinical outcomes in CLI revascularization. ■

Aravinda Nanjundappa, MD, RVT, is Associate Professor of Medicine and Surgery, Division of Vascular Surgery at Robert C. Byrd Health Sciences Center, West Virginia University in Charleston, West Virginia. He has disclosed that he is a paid consultant to Cook Medical. Dr. Nanjundappa may be reached at dappamd@yahoo.com.

Brandon Blankenship, RT, is a vascular interventional radiographer at Charleston Area Medical Center in Charleston, West Virginia. He has disclosed that he has no financial interests related to this article.

Phani Kathari, MD, is Clinical Instructor of the Department of Pharmacology and Pathophysiology at Trinity School of Medicine in St. Vincent, West Indies. He has disclosed that he has no financial interests related to this article.

Nelson L. Bernardo, MD, is Director for Peripheral Intervention with the Division of Cardiology at the Washington Hospital Center in Washington, DC. He has disclosed that he has no financial interests related to this article. Dr. Bernardo may be reached at (202) 877-5975; nelson.l.bernardo@medstar.net.

Yazan Khatib, MD, is Cofounder and Director of Limb Salvage and Endovascular Interventions at First Coast Cardiovascular Institute in Jacksonville, Florida. Dr. Khatib is Cofounder of SALSAL. He has disclosed that he is an owner of or shareholder in CSI 360º.

Albeir Y. Mousa, MD, is Assistant Professor of Surgery at Robert C. Byrd Health Sciences Center, West Virginia University in Charleston, West Virginia. He has disclosed that he has no financial interests related to this article.

Robert S. Dieter, MD, RVT, is Associate Professor of Vascular & Endovascular Medicine and Interventional Cardiology at Loyola University Medical Center in Chicago; and Director of Vascular Medicine and Peripheral Vascular Interventions, Medical Director of the Cardiovascular Collaborative, and Associate Chief of Cardiology at the Edward Hines, Jr. VA Hospital in Hines, Illinois. He has disclosed that he has no financial interests related to this article.

Jihad A. Mustapha, MD, FACC, FSCAI, is Director of Endovascular Interventions and Director of Cardiovascular Research with the Department of Cardiovascular Medicine at Metro Health Hospital in Wyoming, Michigan. He has disclosed that he has no financial interests related to this article.

1. Montero-Baker M, Schmidt A, Bräunlich S, et al. Retrograde approach for complex popliteal and tibioperoneal occlusions. J Endovasc Ther. 2008;15:594-604.
2. Rogers RK, Dattilo PB, Garcia JA, et al. Retrograde approach to recanalization of complex tibial disease. Catheter Cardiovasc Interv. 2011;77:915-925.
3. Sumi M, Ohki T. Endovascular therapy for critical limb ischemia [in Japanese]. Nihon Geka Gakkai Zasshi. 2007;108:194-198.
4. Nice C, Timmons G, Bartholemew P, Uberoi R. Retrograde vs. antegrade puncture for infra-inguinal angioplasty. Cardiovasc Intervent Radiol. 2003;26:370-374.

Transpedal Arterial Access in Practice

Illustrative case studies highlighting this access option and its applications in treating critical limb ischemia.

BY ARAVINDA NANJUNDAPPA, MD, RVT; ROBERT S. DIETER, MD, RVT; NELSON L. BERNARDO, MD; ALBEIR Y. MOUSA, MD; AND JIHAD A. MUSTAPHA, MD, FACC, FSCAI

Transpedal access is an evolving technique primarily used in patients after failed femoral antegrade or retrograde access to revascularize complex tibiopedal lesions. Occasionally, transpedal access is used to revascularize femoropopliteal artery lesions. This article presents three case reports illustrating the use of transpedal access to revascularize tibiopedal occlusions and distal femoropopliteal artery lesions.

Case 1: Pedal Artery Access for SFA Intervention in a Morbidly Obese Patient

A 50-year-old morbidly obese woman presented with a nonhealing ulcer of the left heel (Figure 1). Noninvasive studies showed elevated velocities in the distal superficial femoral artery (SFA) indicative of > 75% stenosis; her left leg ankle-brachial index (ABI) was 0.78. A left leg angiogram showed a significant lesion in the left common iliac artery (CIA) and left SFA (Figure 2). Despite stenting the left CIA, her heel ulcer persisted.

Retrograde femoral puncture was attempted. However, it was difficult to cross over due to the presence of the self-expanding stent in the CIA and a narrow aortoiliac bifurcation. An ipsilateral antegrade puncture was also attempted in the proximal portion of the SFA. The sheath was removed, and manual pressure was held.

Percutaneous transpedal artery access was planned. Duplex ultrasound was used to image the dorsalis pedis artery (Figure 3), and a Micropuncture® needle (Cook Medical, Bloomington, IN) was used to access the pedal artery. A 5-F sheath (Figure 4) was placed in the dorsalis pedis artery, and 3,000 units of heparin were administered for anticoagulation.

Retrograde pedal artery imaging showed the dorsalis pedis artery to be patent with a proximal moderate stenosis in the anterior tibial artery. The SFA was crossed with a 0.014-inch wire, and angioplasty was performed using a 4- X 80-mm balloon. Postangioplasty imaging showed a patent SFA with stent-like results and no residual stenosis (Figure 5).

The vascular access management was performed using a transradial band across the dorsalis pedis artery. A transradial band is usually used for access manage-

Figure 1. Heel ulcer upon presentation.

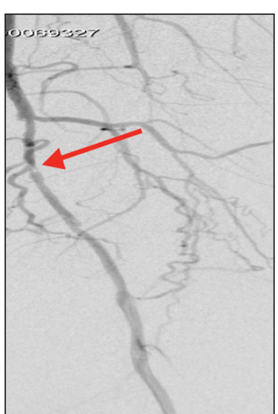


Figure 2. Distal SFA lesion.

Figure 3. Duplex ultrasound imaging of the pedal artery.

Figure 4. A 5-F sheath is placed in the dorsalis pedis artery.

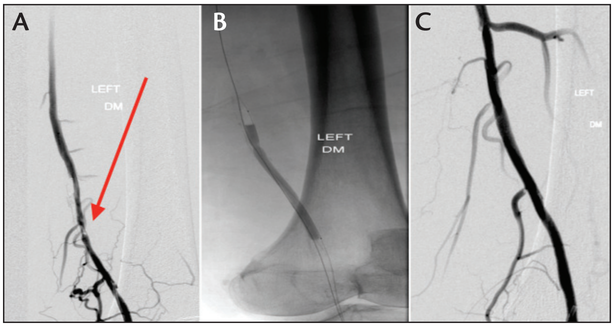


Figure 5. Stenosis of the distal SFA (A). Balloon angioplasty of distal SFA (B). Stent-like results of balloon angioplasty (C).

ment after radial interventions but can be used in the foot if the size accommodates apposition of a transradial band (Figure 6). Upon 12-week follow-up, the patient had complete healing of the heel ulcer, and the access site was also healed (Figure 7).

Figure 6. A transradial band across the access site.

Figure 7. Healing of the access site.

Case 2: Pedal Access to Revascularize a Flush Occluded Anterior Tibial Artery in a Patient With End-Stage Renal Artery Disease

A 78-year-old patient with end-stage renal disease presented with a nonhealing foot ulcer (Figure 1A). Lower extremity angiography revealed patent iliac, superficial femoral (Figure 1B), and popliteal (Figure 1C) arteries. An angiogram of the anterior tibial artery showed a flush occlusion, patent peroneal artery, and occluded posterior tibial artery (Figure 1D). An angiogram of the dorsalis pedis artery showed reconstitution via collaterals (Figure 1E). Percutaneous dorsalis pedis artery access was planned to recanalize the occluded anterior tibial artery.

Duplex ultrasound imaging of the dorsalis pedis artery was obtained, and a 4-F Micropuncture® needle was used to access the artery (Figure 2).

A 4-F Micropuncture® introducer sheath was attached to a Copilot Bleedback Control Valve (Abbott Vascular,

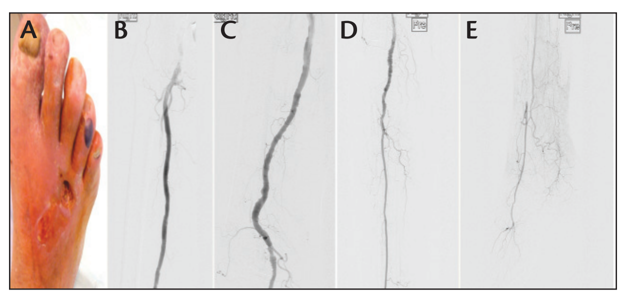


Figure 1. A nonhealing foot ulcer on presentation (A). Lower extremity angiography revealing patent iliac and superficial femoral (B) and popliteal (C) arteries. Anterior tibial artery angiography shows a flush occlusion, a patent peroneal artery, and an occluded posterior tibial artery (D). Dorsalis pedis angiography shows reconstitution via collaterals (E).

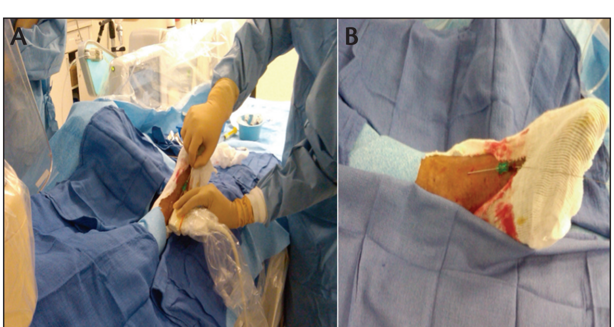


Figure 2. Dorsalis pedis artery access using ultrasound guidance (A) and a Micropuncture® needle (B).

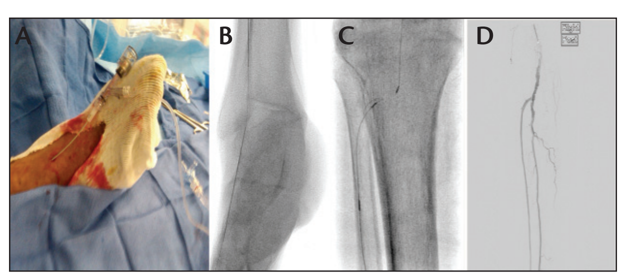


Figure 3. A 4-F Micropuncture® introducer is converted to a sheath with a Copilot valve attached (A). Wire crossing from dorsalis pedis artery (B). Wire in the popliteal artery (C). Patent anterior tibial artery (D).

Santa Clara, CA) to form a temporary sheath (Figure 3A). A 0.018-inch guidewire-compatible CXI catheter (Cook Medical) was used to cross the occluded anterior tibial artery (Figure 3B) into the popliteal artery (Figure 3C).

The wire was removed from the femoral approach, and balloon angioplasty was performed from the femoral artery to treat the occluded anterior tibial artery. The final angiogram showed a widely patent anterior tibial artery (Figure 3D). The 4-F sheath was removed from the pedal artery, and manual pressure was held.

Case 3: SFA Intervention With Dorsalis Pedis Artery Access

A 50-year-old woman with hypertension, diabetes mellitus, hypercholesterolemia, and morbid obesity presented with blue toe syndrome. Physical examination showed palpable pulse in the right femoral artery and absent pulse in the right popliteal artery, dorsalis pedis, and posterior tibial artery. Noninvasive studies showed an ABI of 0.56 in her right lower extremity. A diagnostic angiogram showed a patent right common iliac artery and external iliac artery. The right common femoral artery and popliteal artery were also patent. The SFA was patent in the proximal and mid segments but occluded in the distal segment. The proximal popliteal artery was occluded with reconstitution in the distal segment. The below-knee vessels showed single-vessel runoff via the anterior tibial artery.

The initial attempt at recanalization of the occluded SFA was made with a left femoral artery retrograde access. The wire crossing was subintimal as shown in Figure 1 and failed to reenter the true lumen. Morbid obesity precluded an ipsilateral antegrade approach.

Several options were considered, such as surgical bypass or antegrade puncture of the femoral artery. However, both of these options pose increased risks of complications such as infections and hematoma. We chose the option of pedal access. A dorsalis pedis artery cutdown was performed in the interventional suite (Figure 2). No general anesthesia was used; local anesthesia with conscious sedation was sufficient. A 5-F sheath was placed, and 3,000 intra-arterial units of heparin were administered to prevent clotting and coagulation prior to balloon angioplasty.

The occluded proximal popliteal artery and the distal SFA were crossed with a 0.014-inch wire, and balloon angioplasty was performed using a 4- X 100-mm balloon with prolonged inflation. Postangioplasty images showed a patent distal SFA with a non-flow-limiting dissection (Figure 3). Distal angiography showed patent popliteal and anterior tibial arteries. The dorsalis pedis artery access site was closed with primary sutures. The patient had resolution of her blue toe syndrome and improvement in ABI to 0.72.

CONCLUSIONS

We have discussed three cases of transpedal access to demonstrate the role of this access option in revascularization of tibiopedal vessels and the distal SFA. These cases highlight the role of percutaneous access of the pedal artery. The role of duplex ultrasound to assist pedal artery access is illustrated, and vascular access management ranging from manual pressure, transradial band, and primary surgical closure are shown. The authors hope these case examples will facilitate interventionalists' adoption of the technique of transpedal access in revascularization of tibiopedal lesions and distal femoral popliteal lesions. ■

Figure 1. Retrograde attempt of distal SFA recanalization resulted in subintimal dissection.

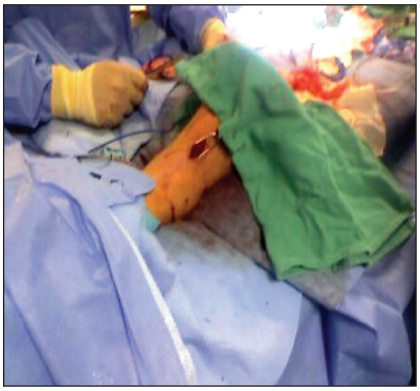


Figure 2. Surgical exposure of the dorsalis pedis artery.

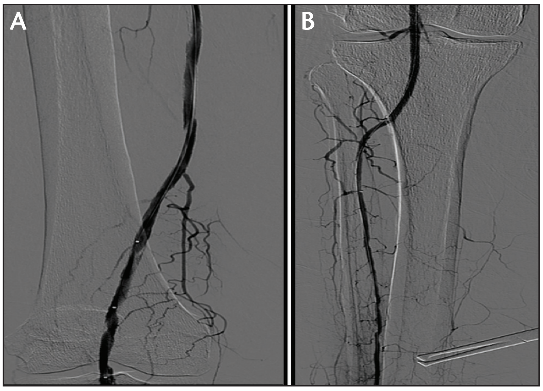
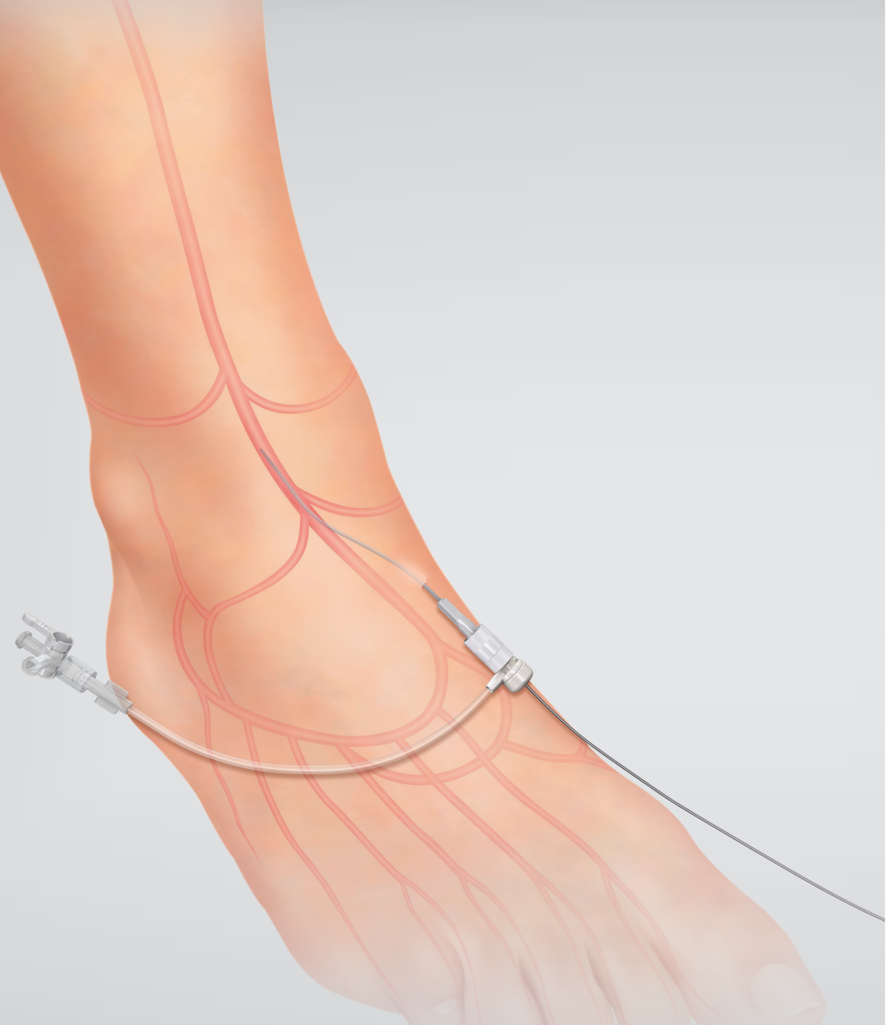


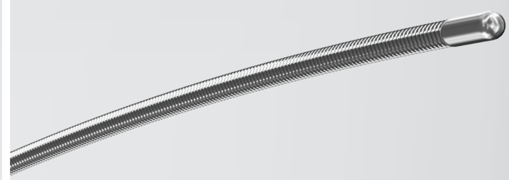
Figure 3. Distal SFA after balloon angioplasty (A). Single-vessel runoff via anterior tibial artery (B).



Micropuncture®
PEDAL ACCESS SET

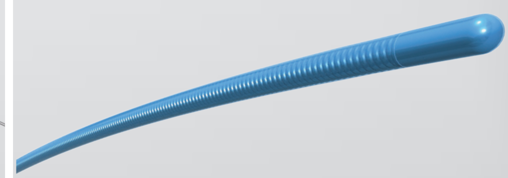
CXI™
SUPPORT CATHETER

- Consistent low profile from tip to hub



Approach® CTO
MICROWIRE GUIDE

- .014 inch



Approach® Hydro ST
MICROWIRE GUIDE

- .014 inch

Expand your options with retrograde tibiopedal access.

To give physicians another chance at limb salvage, Cook Medical offers products designed to facilitate a retrograde tibiopedal approach:

- A supplied hemostasis valve attaches directly to the 2.9 Fr ID Micropuncture Pedal Access Set introducer, allowing it to serve as an interventional introducer.
- The 2.6 Fr CXI Support Catheter can then pass through this introducer.
- The Approach CTO Microwire Guide is available in four tip load options to help cross challenging lesions.
- The Approach Hydro ST Hydrophilic Microwire Guide features a supportive stainless steel shaft and peripheral-specific taper.

Cook Medical–Advancing leg therapies.

COOK® MEDICAL

Contact your Cook Medical representative to learn more about our low-profile technologies.

AORTIC INTERVENTION | CRITICAL CARE | ENDOSCOPY | INTERVENTIONAL RADIOLOGY | LEAD MANAGEMENT | PERIPHERAL INTERVENTION | SURGERY | UROLOGY | WOMEN'S HEALTH