Retrograde Transmetatarsal Artery Access

Below-the-ankle angioplasty for foot preservation in CLI patients.

BY LUIS MARIANO PALENA, MD, AND MARCO MANZI, MD

Today, critical limb ischemia (CLI) due to diabetic arterial disease is a major worldwide cause of morbidity and mortality,[1,2] affecting a large number of patients and can lead to severe disabilities. In fact, major amputations are usually associated with significant increases in mortality risk, and every effort should be pursued to minimize amputations and ensure limb salvage.[3]

Revascularization is the key therapy in these patients because reestablishing adequate blood supply to the foot is necessary to relieve clinical symptoms related to CLI and to avoid major amputations.[4] An endovascular-first approach has increased in acceptance for the treatment of diabetic patients with CLI due to good clinical results.[5-7] Nevertheless, the standard antegrade approach and techniques for recanalizing below-the-knee (BTK) and below-the-ankle (BTA) arteries can still be deficient, with failure rates up to 20%.[8] This is due to the obstructive pattern of the disease, which is characterized by multilevel disease, calcifications, prevalence of chronic total occlusions, and specific involvement of BTK arteries compromising distal runoff at the foot level.[4] In addition to the traditional approach, retrograde access, transcollateral recanalization, and pedal-plantar loop techniques have proven to be beneficial in increasing success rates.[9-11] Even these strategies, however, may fail or be proven unfeasible when the foot arteries are diseased. For this reason, technical improvements and refinements are necessary for endovascular therapy of BTK and BTA atherosclerotic disease. This case-based article focuses on transmetatarsal artery access for BTA and BTK vessel recanalization in the setting of CLI.

ENDOVASCULAR PROCEDURE AND INDICATIONS

Before endovascular therapy, patients are usually pretreated with aspirin (75–160 mg) and ticlopidine (500 mg) or clopidogrel (300 mg loading dose and then 75 mg daily) for 3 days. After local anesthesia is administered, antegrade access to the common femoral artery is achieved under ultrasound guidance with a 9-MHz linear probe (Logiq E9, GE Healthcare), and a 5-F sheath is deployed. Next, 5,000 units of unfractionated heparin are administered.

The revascularization strategy is planned to provide a direct, inline blood supply to the foot (specifically, to the angiosome of any ischemic lesion). The first attempt to recanalize the target vessel is made via antegrade recanalization, according to the standard of care at our institution.[4] When antegrade techniques fail, retrograde recanalization is considered. However, in some cases, transcollateral and/or pedal plantar techniques can also fail, and tibial and/or pedal plantar arteries are occluded or are not suitable for puncture (thin and diseased arteries), so the metatarsal artery access route is considered as an alternative.

TRANSMETATARSAL ARTERY ACCESS AND RETROGRADE RECANALIZATION

This technique has previously been described in the literature.[12-14] The access is created after specific pharmacological support to protect against spasm that compromises the puncture and wiring of the foot arteries. We usually use nitrates (0.5 mg) injected intra-arterially through the common femoral artery sheath and verapamil (5 mg/2 mL) diluted to 10 mL with saline, and 9 mL of this solution is injected intra-arterially as distal as possible, close to the foot. Local anesthesia is administered near the target area at the dorsum of the foot, and 1 mL of diluted verapamil with lidocaine is injected into the subcutaneous tissue.

In the authors' experience, the best site for access is at the dorsum of the foot through the first dorsal metatarsal artery. By way of the dorsal branch of the first metatarsal artery, it is usually possible to reach the plantar arch; cross the arch, then it is possible to recanalize the dorsalis pedis

Figure 1. Diagnostic angiography. Occlusion of the posterior tibial artery and multiple stenoses in the anterior tibial artery (A, B). The laterolateral view (C). A pedal and lateral plantar artery occlusion with thin medial plantar artery patency. The antero-posterior view (D). Patency of the first metatarsal artery. Clinical presentation of the foot, with ischemia of the forefoot and an apical ulcer (TUC IC) in the second toe (E).

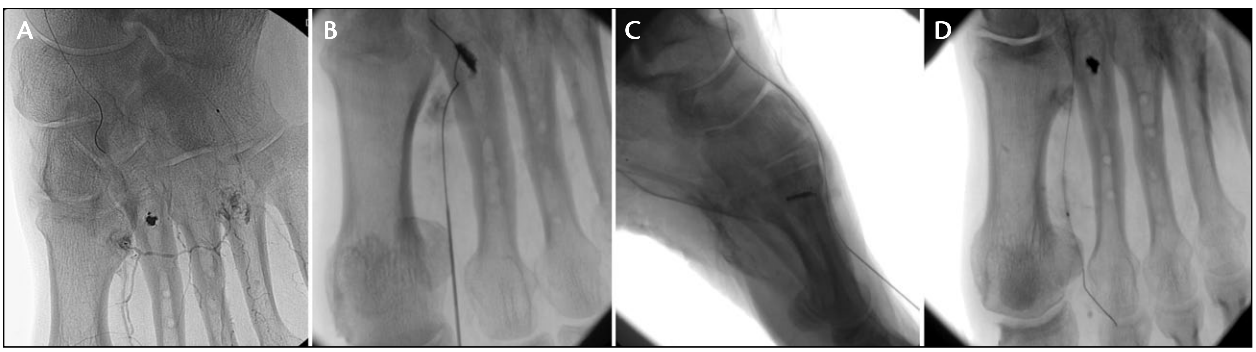

Figure 2. Endovascular treatment. Intraluminal recanalization failure in the pedal and plantar arteries (A). First metatarsal artery punctures and retrograde recanalization of the first metatarsal artery and of the pedal artery (B, C). Antegrade angioplasty and hemostasis at the access site (D).

or lateral plantar artery. The puncture is performed with a 21-gauge needle under fluoroscopic guidance with a contrast medium injection at the maximum magnification to identify the target vessel or under ultrasound guidance with a hockey stick probe (15- to 18-MHz Logic E9).

After metatarsal artery puncture, a 0.018-inch guidewire (V18, Boston Scientific Corporation) is advanced into the artery through the needle, and the microsheath (Micropuncture introducer set, Cook Medical) is deployed. After access is achieved, retrograde intraluminal recanalization of the metatarsal artery and plantar arch is performed, followed by intraluminal or subintimal recanalization of the foot and tibial vessel, and finally the "rendez-vous" technique, which connects the antegrade and retrograde access. The procedure is completed in an antegrade fashion by passing the guidewire beyond the puncture site, retrieving the microsheath and inflating a catheter balloon (1.5–2 mm in diameter), and achieving hemostasis at the metatarsal artery level.

CASE 1

A 65-year-old diabetic man presented for endovascular treatment of CLI (transcutaneous oxygen tension [$TcpO_2$] of 14 mm Hg) and an apical ulcer on the second toe of his left foot (Texas University class [TUC] IC). His comorbidities were hypertension, dyslipidemia, and ischemic heart disease.

Diagnostic angiography showed patency of the femoropopliteal axis and diffuse arterial disease in the BTK and BTA, with distal stenosis of the anterior tibial artery, occlusion of the posterior tibial artery, and occlusion of pedal and lateral plantar arteries (Figure 1). Due to the ulcer location, the anterior tibial artery was first approached by means of intraluminal recanalization (V14, Boston Scientific Corporation), which failed to cross the pedal artery and reach the arch. The second attempt was made with an intraluminal approach of the posterior tibial artery, which failed to recanalize the lateral plantar artery and reach the arch (Figure 2A).

After the antegrade approach failed to recanalize both foot circulatory pathways, retrograde percutaneous transmetatarsal artery access was performed at the level of the first dorsal metatarsal branch (Figure 2B) followed by retrograde recanalization of the first metatarsal artery and the dorsalis pedis (Figure 2C). The procedure was completed in an antegrade fashion, performing percutaneous transluminal angioplasty (PTA) of the anterior tibial artery

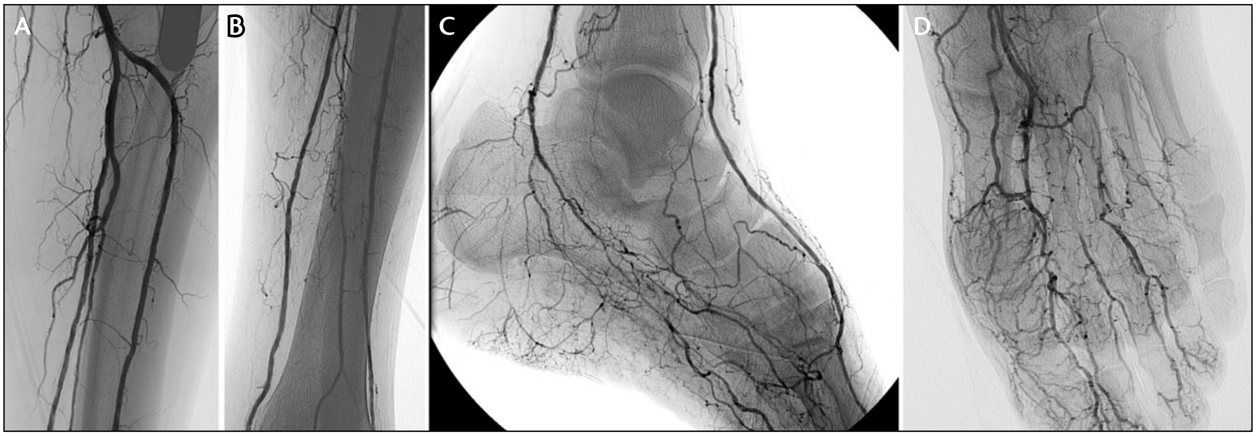

Figure 3. Patency of the anterior and posterior tibial arteries (A, B). Patency of the pedal artery, with direct blood flow to the arch and the forefoot (C, D).

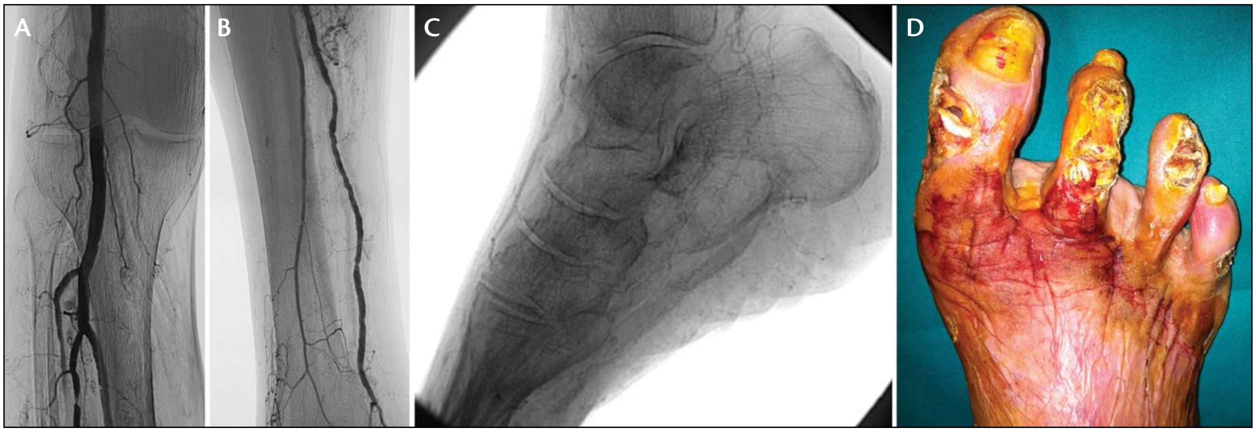

Figure 4. Occlusion of the anterior tibial artery and distal occlusion of the posterior tibial artery (A, B). Slow flow for the foot with occlusion of plantar arteries (C). Clinical presentation of the foot, with gangrene and TUC IIIC lesion on the first, second, fourth, and fifth toes (D).

with a 2.5- to 3-mm X 210-mm conic catheter balloon (Amphirion, Medtronic, Inc.) and PTA of the first metatarsal artery with a 1.5-mm X 20-mm balloon catheter (Coyote ES, Boston Scientific Corporation) (Figure 2D). The final angiographic control images (Figure 3) showed patency of the anterior and posterior tibial arteries, as well as patency of the dorsalis pedis and medial plantar arteries, with direct flow for the arch and for the second toe.

CASE 2

An 86-year-old diabetic man presented with CLI (TcPO2 of 9 mm Hg), gangrene, and a TUC IIIC lesion on the first, second, fourth, and fifth toes. The patient previously underwent amputation of the third toe. His comorbidities included hypertension, ischemic heart disease, chronic renal failure, and pulmonary restrictive disease. The patient was scheduled for transmetatarsal amputation.

Diagnostic angiography showed patency of the femoropopliteal axis, diffuse arterial disease in the BTK and BTA with occlusion of the anterior tibial artery, stenosis of the peroneal artery, distal occlusion of the posterior tibial artery, and occlusion of the plantar arteries (Figure 4). This caused very slow flow to the foot.

Related to the scheduled amputation, the posterior tibial artery was approached by means of intraluminal recanalization (Hi-Torque Pilot 200, Abbott Vascular), which failed to engage and cross the lateral plantar artery and reach the arch. The second attempt was made by subintimal recanalization of the plantar artery, which also failed (Figure 5A).

After antegrade failure, retrograde percutaneous transmetatarsal artery access was performed at the level of the first dorsal metatarsal branch followed by retrograde recanalization of the first metatarsal artery, the plantar arch, and the lateral plantar artery (Figure 5B and 5C). The procedure was completed in an antegrade fashion by performing PTA of the posterior tibial and plantar arteries with a 2.5- to 3-mm X 210 mm Amphirion conic balloon catheter and PTA of the first metatarsal artery with a 2- X 40-mm Amphirion balloon catheter (Figure 5D).

The final angiographic control images (Figure 6A through 6D) showed patency of the posterior tibial and plantar arteries, with direct flow to the arch. The transmeta-

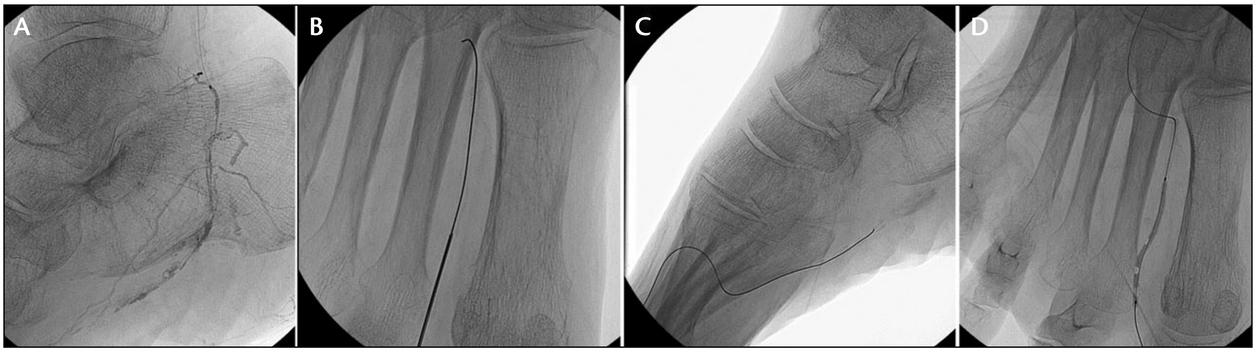

Figure 5. Antegrade recanalization of the posterior tibial artery, which failed by intraluminal and subintimal means (A). Retrograde first metatarsal artery access and retrograde recanalization of the first metatarsal artery, of the plantar arch, and the lateral plantar artery (B, C). Antegrade angioplasty and hemostasis at the access site (D).

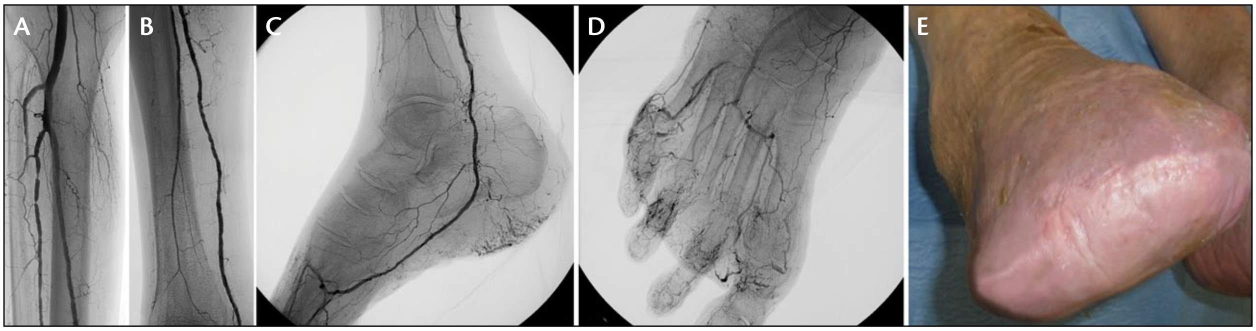

Figure 6. Patency of posterior tibial artery (A, B). Patency of plantar arteries, with direct blood flow to the forefoot (C, D). Transmetatarsal amputation completely healed (E).

tarsal amputation, which occurred the day after, healed completely (Figure 6E).

DISCUSSION

This extreme and advanced technical revascularization strategy, intended for challenging cases of CLI with BTK and BTA arterial disease, has been proven safe and effective for retrograde recanalization and limb salvage.[8] The challenge of this approach, as previously published, remains the radiation exposition for patients and interventionists, which was significant in terms of fluoroscopy time and radiation dose.[8] However, with dedicated ultrasound equipment (15- to 18-MHz hockey stick probe), this problem can be potentially mitigated or solved.

CONCLUSION

Retrograde transmetatarsal artery access appears to be a useful technique for treating BTA and BTK vessels, providing good clinical results in terms of the amputation-free survival rate. It should be reserved for extremely challenging cases after failure of antegrade recanalization has been attempted in patients who are unsuitable for retrograde access in the pedal or plantar arteries and are not candidates for surgical therapy. ■

Luis Mariano Palena, MD, is with the Interventional Radiology Unit, Foot & Ankle Clinic, Abano Terme Clinic, in Abano Terme, Italy. He stated that he has no financial interests related to this article. Dr. Palena may be reached at marianopalena@hotmail.com.

Marco Manzi, MD, is with the Interventional Radiology Unit, Foot & Ankle Clinic, Abano Terme Clinic, in Abano Terme, Italy. He stated that he has no financial interests related to this article.

1. Boulton AJM, Vileikyte L, Ragnarson-Tennvall G, et al. The global burden of diabetic foot disease. Lancet. 2005;336:1719-1724.
2. Faglia E, Clerici G, Clerissi J, et al. Early and five-year amputation and survival rate of diabetic patients with critical limb ischemia: data of a cohort study of 564 patients. Eur J Vasc Endovasc Surg. 2006;32:484-490.
3. TASC II Working Group. Inter-society consensus for the management of peripheral arterial disease (TASC II). J Vasc Surg. 2007;45(suppl S):S5-S67.
4. Ferraresi R, Palena LM, Mauri G, et al. Tips and tricks for a correct endo approach. J Cardiovasc Surg. 2013;54:685-711.
5. Faglia E, Dalla Paola L, Clerici G, et al. Peripheral angioplasty as the first-choice revascularization procedure in diabetic patients with critical limb ischemia: prospective study of 993 consecutive patients hospitalized and followed between 1999 and 2003. Eur J Vasc Endovasc Surg. 2005;29:620-627.
6. Dorros G, Jaff MR, Dorros AM, et al. Tibioperoneal (outflow lesion) angioplasty can be used as primary treatment in 235 patients with critical limb ischemia: five-year follow-up. Circulation. 2001;104:2057-2062.
7. Romiti M, Albers M, Brochado-Neto FC, et al. Meta-analysis of infrapopliteal angioplasty for chronic critical limb ischemia. J Vasc Surg. 2008;47:975-981.
8. Palena LM, Brocco E, Manzi M. The clinical utility of below-the-ankle angioplasty using "transmetatarsal artery access" in complex cases of CLI. Catheter Cardiovasc Interv. 2014;83:123-129.
9. Gandini R, Pipitone V, Stefanini M, et al. The "Safari" technique to perform difficult subintimal infragenicular vessels. Cardiovasc Intervent Radiol. 2007;30:469-473.
10. Fusaro M, Agostini P, Biondi-Zoccai G. Trans-collateral angioplasty for a challenging chronic total occlusion of the tibial vessels: a novel approach to percutaneous revascularization in critical lower limb ischemia. Catheter Cardiovasc Interv. 2008;71:266-272.
11. Manzi M, Fusaro M, Ceccaci T, et al. Clinical results of below-the-knee interventions using pedal-plantar loop technique. J Cardiovasc Surg. 2009;50:331-337.
12. Manzi M, Palena LM. Retrograde percutaneous transmetatarsal artery access: new approach for extreme revascularization in challenging cases of critical limb ischemia. Cardiovasc Intervent Radiol. 2013;36:554-557.
13. Manzi M, Palena LM. Extreme options after failed antegrade CLI treatments. Endovasc Today. 2013:1:48-52.
14. Palena LM, Manzi M. Extreme below-the-knee interventions: retrograde transmetatarsal or transplantar arch access for foot salvage in challenging cases of critical limb ischemia. J Endovasc Ther. 2012;19:805-811.