Use of Collaterals for Retrograde Recanalization

Techniques for utilizing collateral vessels as an alternative to distal puncture when antegrade recanalization fails.

BY JOS C. VAN DEN BERG, MD, PHD

The endovascular treatment of critical limb ischemia has been facilitated by the development of dedicated interventional tools, an increase in the experience of interventionists, and the availability and use of alternative access routes (eg, pedal access). Because of this, technical success rates have significantly increased. In this article, the use of collateral vessels for retrograde recanalization of occluded infrainguinal arteries is discussed and illustrated with three representative case reports.

CASE 1

A 70-year-old man was referred to our center for critical ischemia of the left lower leg. Duplex ultrasound revealed diffuse arterial disease of the superficial femoral and popliteal arteries, with a suspicion of below-the-knee disease. Diagnostic angiography confirmed the presence of multiple significant stenoses of the superficial femoral artery (SFA) and popliteal artery, as well as subtotal occlusion of the tibioperoneal trunk (Figure 1A). The posterior tibial artery was occluded from its origin, with a patent intermediate segment and a second occlusion that was more distal. The fibular artery had a very narrow caliber but was patent until the level of the ankle (Figure 1B). A large collateral branch was seen toward the distal posterior tibial artery. After revascularization of the SFA and popliteal artery, the tibioperoneal trunk was recanalized, and the fibular artery was treated with balloon angioplasty. Antegrade recanalization of the posterior tibial artery was attempted, but was not successful. It was then decided to perform retrograde recanalization of the posterior tibial artery using the large fibular collateral for access. A 2.5- X 80-mm Amphirion Deep

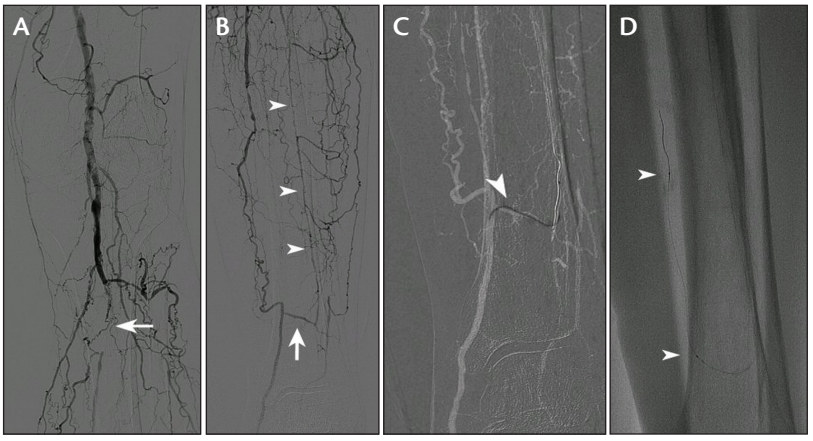

Figure 1. Digital subtraction angiography (DSA) demonstrating occlusion of the posterior tibial artery (arrow); note the stenoses of the popliteal artery and tibioperoneal trunk (A). DSA demonstrating patency of the fibular artery (arrowheads) and presence of a large collateral from the fibular to the distal posterior tibial artery (arrow; B). Road map image demonstrating passage of a guidewire (arrowhead) through the collateral into the posterior tibial artery (C). Fluoroscopic image demonstrating passage of a balloon angioplasty catheter (arrowheads) in a retrograde fashion through the posterior tibial artery (D).

balloon (Medtronic) was advanced into the distal fibular artery. Subsequently, the collateral was cannulated with a 0.014-inch Advantage guidewire (Terumo Interventional Systems), and the guidewire was advanced in a retrograde fashion into the posterior tibial artery (Figure 1C). After complete retrograde crossing of the guidewire, the angioplasty balloon was advanced, and angioplasty was performed (Figure 1D). Control angiography demonstrated a two-vessel runoff. The clinical course was uneventful.

CASE 2

A 78-year-old man was referred for ischemic rest pain of the left foot. Duplex ultrasound demonstrated patency of the SFA and popliteal artery. The patient was scheduled for angiographic evaluation and endovascular treatment of suspected below-the-knee disease. Digital subtraction angiography (DSA) demonstrated an occlusion of the posterior tibial artery with distal filling through collaterals (Figure 2A). An occlusion of the fibular artery was also noted, with two collaterals connecting to the distal fibular artery in the absence of a proximal stump (Figure 2B). The anterior tibial artery was occluded as well. Antegrade recanalization of the posterior tibial artery was successfully performed; however, antegrade recanalization of the fibular artery was not possible due to the absence of a proximal stump and the guidewire following a preferential course into one of the two collaterals (Figure 2C).

A 4-F diagnostic catheter (multipurpose shape, 0.038-inch lumen) was advanced into the proximal part of the fibular artery (Figure 2D), and a 0.014-inch guidewire (Advantage) was advanced in the collateral that was seen to connect to the proximal part of the patent segment of the fibular artery. Subsequently, a 2.6-F CXI support catheter (Cook Medical) was advanced over the guidewire through the diagnostic catheter, with the tip into the proximal part of the collateral, to enhance support for the guidewire (Figure 2E). After this, the 0.014-inch guidewire was advanced through the collateral and into the fibular artery. The tip of the guidewire was deflected cranially and was advanced and looped until the occluded segment was crossed entirely.

At the point where the loop was well into the popliteal artery, the support catheter was removed (Figure 2F), and a second 0.014-inch guidewire (Hi-Torque Command, Abbott Vascular) was advanced through the diagnostic catheter and navigated toward the point of "exit" of the first guidewire at the proximal end of the occlusion (Figure 2G). The second guidewire easily entered the occluded segment and followed the course of the first guidewire. After advancement of the second guidewire into the patent distal fibular artery, the first guidewire was removed, and antegrade balloon angioplasty was performed with a good angiographic outcome. Clinically, the patient improved significantly and became asymptomatic.

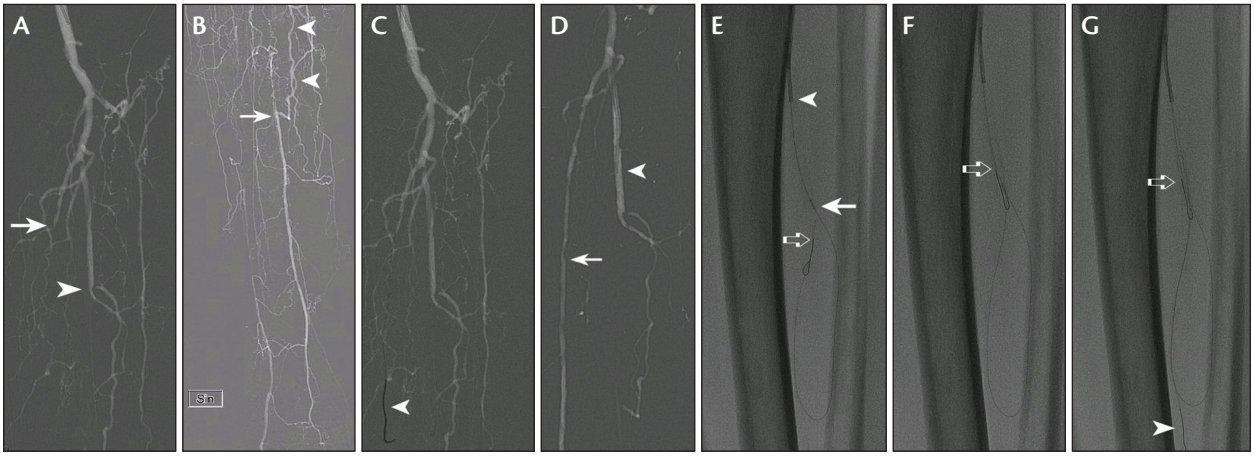

Figure 2. Road map image demonstrating occlusion of the posterior tibial artery (arrow) and fibular artery (arrowhead; A). A large collateral (fibular to fibular, arrowheads) and distal fibular artery (arrow; B). Antegrade passage of a guidewire (arrowhead) through the posterior tibial artery (C). Road map image obtained after angioplasty of the posterior tibial artery demonstrating patency (arrow); a 4-F diagnostic catheter (arrowhead) has been advanced in the proximal fibular artery (D). Fluoroscopic image depicting the tip of the diagnostic catheter (arrowhead), the tip of the support catheter (arrow), and the looped guidewire (open arrow; E). Fluoroscopic image after further advancement of the guidewire loop (open arrow) and removal of the support catheter (F). Fluoroscopic image after antegrade passage of second guidewire (arrowhead) next to the looped guidewire (open arrow; G).

CASE 3

An 87-year-old woman presented at our institution with a left forefoot ulcer. Diagnostic angiography demonstrated a patent femoropopliteal axis and single-vessel outflow (fibular artery). Collateral filling of the distal anterior tibial artery and the plantar artery was seen (Figure 3A through 3C). A small proximal stump of the anterior tibial artery was present. Antegrade recanalization was not possible, and after placement of a 4-F diagnostic catheter with its tip at the distal popliteal artery, a 2-F microcatheter (Stridesmooth+, Asahi Intecc Co LTD) was advanced in the distal segment of the fibular artery, and a road map image was obtained (Figure 3D).

Through the microcatheter, a 0.012-inch guidewire (Glidewire GT, Terumo Interventional Systems) was advanced through the collateral into the patent distal segment of the anterior tibial artery. A guidewire loop was formed, and the guidewire and microcatheter were advanced in a retrograde fashion through the anterior tibial artery (Figure 3E). The guidewire was further advanced into the popliteal artery. Subsequently, the microcatheter was removed, and in a similar fashion as in Case 2, a 0.014-inch Hi-Torque Command guidewire was advanced until the dorsal pedal artery was reached (Figures 3F and 3G). Balloon angioplasty of the anterior tibial artery was performed with a long 2.5-mm balloon, with reconstitution of direct antegrade flow toward the foot. Wound healing was uneventful.

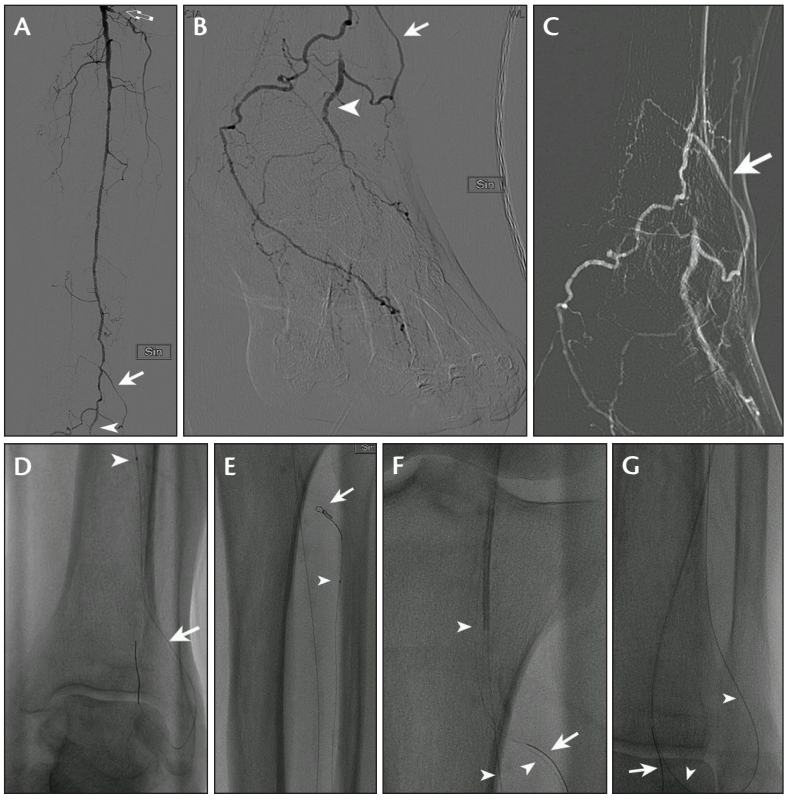

Figure 3. DSA of the left lower leg demonstrating occlusion of the anterior tibial artery with a small proximal stump (open arrow) and a patent fibular artery with a collateral (arrow) toward the dorsal pedal artery (arrowhead; A). DSA of the left foot showing the collateral (arrow) and dorsal pedal artery (arrowhead) in detail (B). Selective road map in anteroposterior projection showing the course of the collateral (arrow; C). Fluoroscopic image depicting the tip of the microcatheter (arrowhead) and the guidewire passing through the collateral into the distal anterior tibial artery (arrow; D). Fluoroscopic image demonstrating a looped guidewire (arrow) and microcatheter (arrowhead) advanced to the proximal segment of the anterior tibial artery (E). Fluoroscopic image showing a guidewire used for retrograde recanalization (arrowheads) and a second guidewire crossing in antegrade fashion (arrow; F). Fluoroscopic image at the level of the ankle demonstrating the first guidewire from the fibular artery to the anterior tibial artery (arrowheads) and the antegrade guidewire entering the dorsal pedal artery (G).

DISCUSSION

Retrograde recanalization of occluded infrainguinal arteries after failed antegrade attempts has become part of the armamentarium of interventionists involved in the treatment of critical limb ischemia. In order to perform a retrograde recanalization, two options are available. The first option is achieving distal access, either at the level of the foot (the most commonly used access site is the dorsal pedal artery) or anywhere between the knee and the ankle. The second way to achieve a retrograde orientation of guidewire and catheter is the use of collateral vessels. The technique of using collaterals to recanalize in a retrograde fashion has been developed in the coronary territory, where distal access is not an option.[1] It has also been used in the iliac and SFA territory.[2] As previously described, this technique combines a retrograde and antegrade approach from a single entry site, thus allowing optimal use of the (common femoral) antegrade access site. Contrary to direct distal access, larger-bore introduction

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sheaths can be used, in case more bulky ancillary material is needed.

When using the collateral pathway, two techniques exist. In cases where a large collateral is present, after crossing with a 0.014-inch guidewire, the angioplasty balloon can be advanced through the collateral, and angioplasty can subsequently be performed (Case 1).[3] In cases where the collateral vessel has a small caliber or is very tortuous, crossing with a balloon catheter may not be possible. In this situation, retrograde passage of only a wire may be sufficient to pave the way and create a track for a second guidewire in an antegrade fashion (Cases 2 and 3). The latter technique has been called the "kissing-wire" technique.[4] With the kissing-wire technique, oftentimes, a microcatheter (coaxially with a 4-F diagnostic catheter) needs to be used in order to enhance pushability and steerability of the guidewire. In extremely tortuous collaterals, it may be necessary to use guidewires smaller than 0.014 inch (wires typically used in neurointerventional procedures). Once the microcatheter has crossed the tortuous segment (typically the bends in the collateral are "stretched out" at this point), the original 0.014-inch or even a 0.018-inch guidewire may be reinserted to increase pushability and penetration power.

Once the first (retrograde) guidewire is passed, the second guidewire can be crossed next to the first guidewire in the diagnostic catheter. In case a microcatheter was used to cross, this microcatheter should be removed before inserting the second guidewire. Once the second guidewire has successfully crossed the occlusion, the first guidewire can be removed, followed by removal of the diagnostic catheter and subsequent completion of the (antegrade) balloon angioplasty. As an alternative, two microcatheters can be used during a transcollateral approach.[5] This so-called rendezvous technique requires a larger-sized introduction sheath (6 F).

There are several advantages of the transcollateral approach. No additional access site needs to be prepared, and no specific tools are needed for distal access. There will not be any additional problems related to hemostasis at the distal puncture site, and finally, there will be less risk of radiation exposure to the operator's hand (especially in situations when a fluoroscopy-guided puncture is used). The technique can also be used in cases when distal arteries are small, diseased and/or calcified, and difficult or impossible to puncture (likewise, the transcollateral approach is not possible in the absence of sufficiently large collaterals).

When using collaterals, several aspects need to be kept in mind. As with distal access, one should avoid "burning bridges." With distal access, it is important not to sacrifice any potential distal anastomotic sites, and when using collaterals, one should avoid crossing through the last remaining collateral.

In conclusion, the transcollateral approach is feasible and safe and should be considered an alternative to distal puncture in cases of failed antegrade recanalization. ■

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