The Retrograde Approach for BTK Chronic Total Occlusions

Tools and techniques for achieving access in even the most complex cases.

BY MIGUEL MONTERO-BAKER, MD

Multiple authors have published data on outcomes after endovascular therapy for complex tibioperoneal disease, demonstrating a staggering 20% to 40% technical failure rate with the antegrade approach.[1,2] Unfortunately, due to the high morbidity in the population with critical limb ischemia, it is not rare that they are deemed unfit for open surgery. However, advancements in device technology and technical skills have resulted in higher technical success rates. This article describes the steps of and technical tips for one such technique: retrograde access.

BACKGROUND AND RATIONALE OF THE RETROGRADE APPROACH

The first published successful experience using a retrograde approach to recanalize a tibial vessel was by Iyer et al in 1990, via cutdown of the posterior tibial artery.[3] The first hypothesis about the benefit of using alternative retrograde wire passage was described amply by Ozawa et al in 2006.[4] Although this article exemplifies retrograde chronic total occlusion (rCTO) crossing in the coronary arteries, the physiopathological fundamentals can be extrapolated, with some reserve, to below-the-knee procedures. Briefly, the technical hurdle with antegrade guidewire passage is failure to penetrate the proximal cap or to accomplish distal luminal re-entry, the main reason being differential fibrotic cap composition. A complex and hard proximal fibrotic cap will prevent wires from crossing or push them quickly into the subadventitial space. The distal fibrotic cap is said to be "either very thin or nonexistent."[4]

Moreover, there are potentially invisible residual true lumen channels that taper proximally to their narrowest area, which, as a result, are invisible on angiography.

In general terms, the objective of retrograde access is to aid in lesion traversability. Once the lesion is crossed and the wire is secured in the proximal true lumen, most operators recommend recapturing the wire from the proximal conventional access site and then using it as a rail (a through-and-through configuration that is achieved by establishing the wire from the pedal to the groin access site). Finally, once the lesion is crossed in an antegrade fashion with a support catheter or a balloon catheter, the wire is pulled out of the pedal access site and repositioned in the usual antegrade configuration. Hemostasis of the pedal puncture site is achieved with a combination of simple direct pressure and endohemostasis (inflation at the level of the puncture site of an angioplasty balloon sized one-to-one to the vessel at a low atmospheric pressure for 2 to 4 minutes). The development of newer devices with lower profiles has allowed operators to utilize retrograde access not only for lesion crossing, but also for use during treatment.[5]

From a technical standpoint, interventionists should have an algorithm that allows them to maneuver through the multitude of scenarios that will guide them from access to success. Among the most important decision-making steps are selection of the target vessel, determination of the level of vessel access, selection of an access-securement modality, selection and use of ideal imaging for access guidance, selection of rCTO tools, and knowledge of bailout techniques for ultra-complex scenarios.

TARGET VESSEL SELECTION

The first step of any successful procedure is having detailed angiography of the below-the-knee vessels. A selective catheter down to the popliteal artery, collimation, and digital subtraction angiography are probably the best possible combination for ideal mapping. Moreover, attention must be paid to acquiring multiple angled views that will enable adequate decision making.

The vessel with the best distal angiographic integrity should be chosen first. The decision making process is equivalent to selecting the ideal runoff vessel for a pedal bypass. Mainly, selection is based on continuity with the pedal arch.[6,7] If conditions allow a choice between different vessels, it is the general consensus in the vascular practice to select therapy based on the angiosome distribution of the lesion.[8]

Although Azuma et al have previously published work opposing any advantage of angiosome-directed therapy, it was found that the healing rate for indirect angiosome revascularization was significantly slower than in the direct revascularization group, especially in the end-stage renal disease subgroup analysis of patients.[9] Our group has an ongoing hypothesis that microvascular disease negatively affects the luminal caliber and/or physiologic flow adaptability of the choke vessels (interangiosome vessels), which is demonstrated by the now-well-described "orphan heel syndrome" of patients with intact forefoot perfusion (to the extent of some cases having a palpable dorsalis pedis pulse) but an ischemic hind foot.[10] As a result, the need to have options for extreme revascularization by means of technically demanding scenarios (eg, rCTOs) of specific vessels becomes imminent (Figure 1).

DETERMINING THE VESSEL ACCESS LEVEL

This is a simple concept: access should be secured close to the area of reconstitution. Long areas of nondiseased vessel will hinder force vectors and minimize pushability. Moreover, vessel spasm is not infrequent, and the interventionist must always preserve the general principle to minimize unnecessary contact between a healthy vessel and the wire or catheter. With these principles in mind, in general terms, there will be two groups: proximal (or high) and distal (or low pedal) retrograde access. Figure 2 describes the alternative access levels with angiographic examples.

SELECTING AN ACCESS-SECUREMENT MODALITY

Initial experience in the 1990s described cutdown as a means of accessing vessels, and although bailout surgical cutdown might come in handy, the operator will rarely need to resort to this. More recent published experiences have demonstrated safe results with percutaneous vessel access across a multitude of publications.[11] Recently, an industry-sponsored multicenter registry of nearly 200 patients who underwent rCTO therapy also concluded that the technique was safe and associated with high technical success rates (tibiopedal study sponsored by Cook Medical; unpublished data).

Once operators secure access, there are two basic options: a sheathless or micropedal sheath technique (Figure 3). Historically, complications associated with pedal access were related to large-bore sheaths and should be avoided.[2] The sheathless technique was used initially and has the hypothetical advantage of creating a smaller arteriotomy. Operators secure a long wire in the vessels via the usual Seldinger technique, but then support the wire with either a low-profile balloon or catheter directly through the skin. The drawbacks associated with this are the potential risk of losing access during device exchange and the lack of a port that can be used for administering medications (eg, antivasospastic drugs) or injecting contrast to obtain angiographic control images.

The current practice is to secure the access with use of a 2.9-F micropuncture pedal access set (Cook Medical). This secures low-profile access during the entire procedure. Operators can freely change devices and wires without compromising access, and there is a port to inject medications or contrast. Although most balloons on the market are not compatible with an extremely small inner lumen diameter, the Micro 14 (Cook Medical) is a newly approved device that defies this hurdle.

Figure 1. Complex critical limb ischemia scenario: WIFI class 3-3-2[12] with long anterior tibial occlusion status after failure of antegrade recanalization (A). Dorsalis pedis percutaneous retrograde access (B). Retrograde wire passage with low-profile angioplasty balloon support (C). Final angiographic result after angioplasty (D and E).

IMAGING TECHNIQUE FOR ACCESS

Operators can choose from fluoroscopy, ultrasound, or a combination of both to achieve access. Although most of the initial experience published used fluoroscopy alone to achieve access, fluoroscopy comes with the same risks associated with radiation exposure for both the operator and the patient.[13] If there are alternative, safe means to achieve access, these should always be selected first.[14] Ultrasound access allows the interventionist to subselect an area with less anterior wall calcification within the target vessel, view the echo needle penetrating the arterial wall in real time, view wire passage through the artery, and visualize securement of the micropedal sheath or crossing device in the artery.

SELECTING rCTO TOOLS

In general, the combined use of a low-profile catheter/balloon and a hydrophilic, torque-responsive 0.014- or 0.018-inch wire is advisable. The exact combination will be determined by whether the interventionist wishes to secure sheathless access or access with a micropedal sheath.

If access is achieved with a micropedal sheath, the best option would be to use small-profile support catheters. These catheters add the value of technology engineered for support, will usually have some hydrophilic coverage, and have a varied array of angles to allow direction and redirection of the retrograde luminal or subadventitial wire navigation. On the other hand, the use of a balloon as a support catheter allows angioplasty immediately after crossing, preventing a delay in treatment and the additional cost burden of using a support catheter first.

Our current approach is as follows: in shorter lesions usually associated with high (proximal) access sites, a V18 control wire (Boston Scientific Corporation) or a Roadrunner 18 wire (Cook Medical) is floated into the vessel after puncture is performed via a micropuncture needle (21-gauge needle). Once luminal positioning is secured, a small incision with a No. 11 blade is made at the puncture site, and the wire is supported with a 0.018-inch Quick-Cross catheter (Spectranetics Corporation).

In the event that the lesion is complex (multilevel, long, and calcified), low (distal pedal) access is secured with a micropedal sheath. Our current go-to wires are

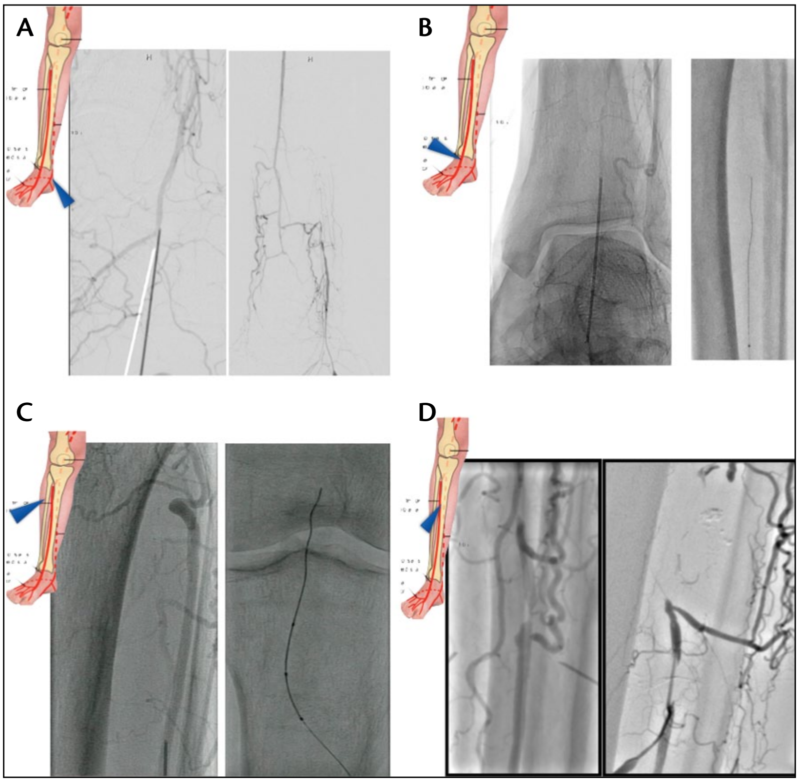

Figure 2. Access levels. Low/distal posterior tibial access (A). Low/distal dorsalis pedis access (B). High/proximal anterior tibial access (C). High/proximal peroneal access (D).

the 0.014-inch Command ES wire (Abbott Vascular), 0.014-inch PT2 wire (Boston Scientific Corporation), and 0.014-inch Roadrunner wire (Cook Medical), supported with a 0.014-inch Quick-Cross catheter (Spectranetics Corporation) or any of the CX family of catheters (Cook Medical). In the event that this fails, a more aggressive subintimal approach is undertaken with 0.018-inch systems.

BAILOUT TECHNIQUES FOR ULTRA-COMPLEX SCENARIOS

Unfortunately, even if all of these techniques are properly employed, sooner or later, interventionists will find themselves in situations when crossing is impossible. The following paragraphs describe our three main bailout techniques.

Double-Wire Flossing

Previously, authors such as Spinosa et al have detailed the use of two wires to improve success rates, mainly for complex superficial femoral artery/popliteal lesions,[15] but the same principle applies to below-the-knee occlusions. Ideally, this requires that a second interventionist be available. Both interventionists will then proceed to manipulate both wire or support systems from above and below; the objective is to create enough plaque disruption and microchannels until both wires ultimately arrive in the same dissection plane. Once this step is accomplished, wires will usually slide next to each other and find either the proximal vessel lumen with the retrograde wire or the distal vessel lumen with the antegrade wire.

Double-Balloon Disruption

When double-wire flossing is unsuccessful, operators should be advised to float balloon angioplasty catheters via the antegrade and retrograde approach until the tips of the balloons are opposed. Due to the nature of balloon designs, there will usually be some shoulder distal to the markers that determines the end of the balloon. The idea is to oppose both markers at no more than 2 mm. At that point, the wire should be pulled back into the angioplasty catheters; next, both balloons will be inflated at the same time. Usually, low pressure (4 to 6 atm) tends to be enough to accomplish the objective of creating enough plaque dispersion and disruption to allow wire passage. In other words, once both opposing balloons are inflated for a brief period of time (1 minute should suffice) and then deflated, both wires are maneuvered from antegrade and retrograde to attempt crossing into either space (Figure 4).

Virtual True Lumen Via Retrograde Balloon Inflation

When the previous two techniques result in unsuccessful crossing, operators should consider a combina-

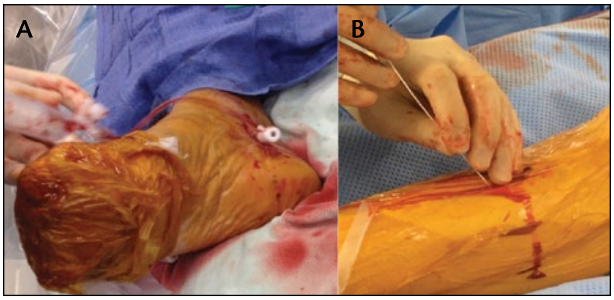

Figure 3. Access securement. Micropedal sheath approach (A). Sheathless approach (B).

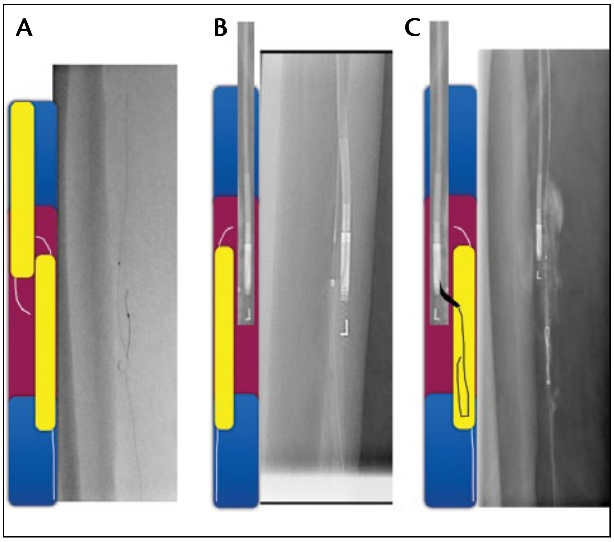

Figure 4. Bailout techniques for ultra-complex lesions (graphic and angiographic examples). Double-balloon disruption: opposing balloons used to create plaque displacement and/or disruption (A). Virtual true (v-true) lumen via retrograde balloon inflation: alignment of the antegrade re-entry device and retrograde balloon (B); wire capture inside the v-true after puncture with the re-entry device (C).

tion of a re-entry device and virtual lumen creation via balloon insertion from the retrograde access site. In this technique, when both wires are in different dissection planes, the retrograde access wire allows a balloon to navigate up into the blind segment of the dissection. The antegrade wire will allow a hollow-needle re-entry device (eg, Outback catheter, Cordis Corporation) to navigate downward into the other blind dissection space. Once aligned, the re-entry device can be projected into the virtual lumen created by the inflated balloon. The wire will track into the ruptured lumen of the balloon, and then both the balloon and the trapped wire can be pulled down. This maneuver will secure the antegrade wire into the retrograde dissection space, allowing for therapy (Figure 4).

CONCLUSION

The general therapeutic algorithm is summarized in Figure 5. Retrograde access for complex tibioperoneal disease has proven to be a safe and efficacious technique for expanding therapy to patients with poor options and failed previous attempts. Interventionists should be encouraged to read, practice, receive training, and use this technique in their daily practices. ■

Miguel Montero-Baker, MD, is with the University of Arizona Department of Vascular and Endovascular Surgery and Pima Vascular, Tucson, Arizona. He has disclosed that he has served as proctor and speaker for Cook Medical and Abbott Vascular. Dr. Montero-Baker may be reached at montero.bkr@gmail.com; Twitter: @monteromiguel.

Step 1:
Target Vessel Selection

Step 2:
Vessel Level Selection

Step 3:
Access-Securement Modality Selection

Step 4:
Imaging Technique Selection

Step 5:
Bailout rCTO Tools Selection

Figure 5. Step-by-step approach to accomplishing retrograde tibial endovascular work.

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