Crossing Peripheral CTOs

A look at today's options, from guidewires to re-entry devices.

BY TONY DAS, MD

Chronic total occlusions (CTOs) account for a significant portion of the peripheral vascular disease lesions encountered by endovascular interventionists. The ability to successfully cross long total occlusions and re-enter the true lumen is directly related to acute procedural success and long-term patency. Standard guidewire recanalization has been our technique of choice for most long, occlusive lesions. In fact, technical success for crossing long (>10 cm) superficial femoral artery (SFA) occlusions ranges from 50% to 90%, depending on lesion length, calcification, operator experience, and runoff vessel status. Until recently, this was the only approach for complex occlusive lesions. Recent advances in wire technology and adjunctive devices have increased the interventional armamentarium for this challenging disease subset. This article describes one operator's technical tips and tricks for successful recanalization of the SFA using wires, lasers, and re-entry catheters to achieve procedural success.

BACKGROUND

Occlusions outnumber stenoses for advanced SFA disease. As endovascular approaches supercede surgical therapy for the management of complex peripheral vascular disease, the tools and techniques for long-segment SFA recanalization become more necessary for the interventionist. When evaluating a patient with advanced, symptomatic peripheral vascular disease, one is commonly faced with complex lesions, classified as TASC D.[1] These long segments of occlusive SFA disease previously fell under the purview of the surgeon who performed traditional femoropopliteal bypass surgery. A relatively new group of devices called re-entry catheters has changed the technical success of traversing these complex lesions without surgical intervention. In addition, the recently published midterm success of self-expanding nitinol stents in the SFA has also stimulated interest in tackling these long SFA occlusions with an endovascular approach.[2]

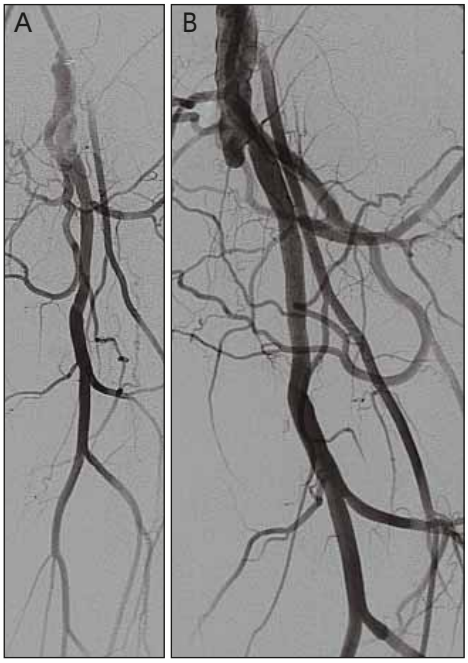

Figure 1. Occluded SFA imaged in the AP view obscures the proximal stump (A). Ipsilateral lateral angulation of 35° to 40° allows proximal stump visualization (B).

LESION ASSESSMENT

Most long SFA occlusions begin with a proximal stump followed by varying degrees of distal vessel reconstitution by way of collaterals from the profunda femorus artery. Angiographic assessment of the proximal stump requires a 35° to 40° ipsilateral lateral angiogram (Figure 1). In this view, one can determine the length of the proximal stump and the possible access options, including antegrade, contralateral, or even

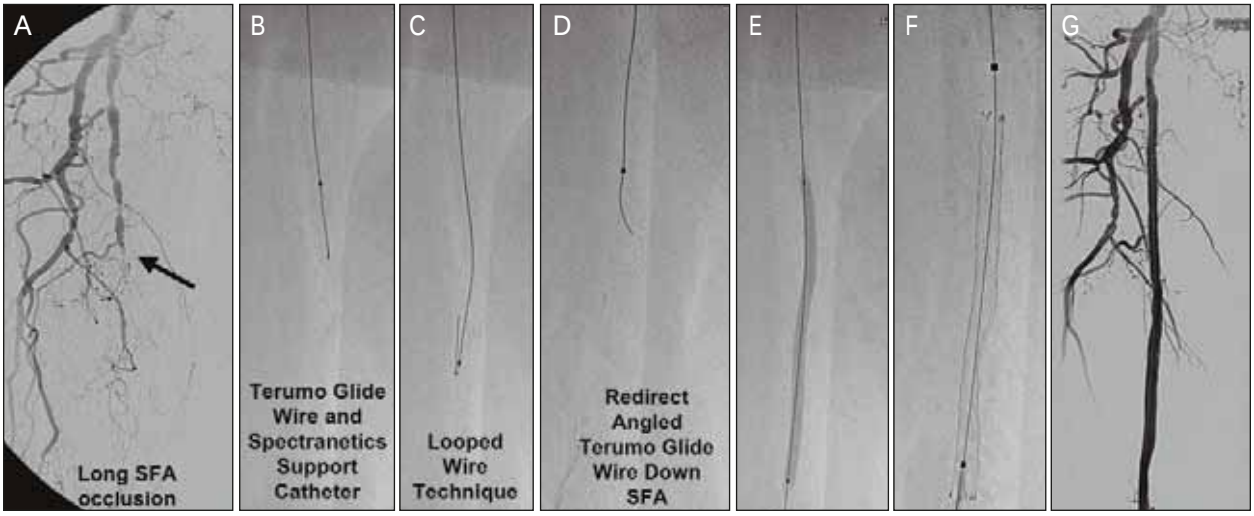

Figure 2. Arrow shows the occluded right SFA (A). A non-looped Glidewire entering the occlusion with the support catheter (B). A small loop is used to dissect the SFA occlusion (C). The wire is straightened before distal re-entry site (D). A 5-mm X 10-cm PTA balloon is placed (E). Deployment of the SFA self-expanding stent (F). Final angiographic result (G).

brachial approaches. If the proximal stump or cap is less than 3 cm to 5 cm long, management of the ostial SFA segment must be factored into device selection. In addition, the location of the distal reconstitution strongly influences device choice for re-entry catheters. Re-entry catheters have the highest degree of success in lesions that reconstitute above the adductor canal, where the vessel is relatively large. If the occlusion does not collateralize until the popliteal artery or even lower, re-entry becomes more challenging.

GLIDEWIRE TECHNIQUE

Because many SFA occlusions have a shorter stump than 11 cm (the length of most femoral sheaths), entry is commonly achieved from the contralateral femoral approach. Once access with a crossover sheath is obtained, the simplest recanalization strategy remains the combination of a hydrophilic guidewire coupled with the support of a low-profile catheter. A typical combination may include the .035-inch angled Glidewire (Terumo Medical Corporation, Somerset, NJ) coupled with a 4-F to 5-F straight Glide Catheter. This solid core, hydrophilic wire possesses resilient properties allowing initial entry into the occlusive lumen, followed by purposeful creation of a wire loop to pass into the subintimal space. Some interventionists prefer the combination of a straight wire with an angled catheter. In any case, a successful technique requires a few simple caveats (Figure 2). First, the hydrophilic guidewire should enter the occlusion with the tip uncurled or straight. This allows the tip to engage the lesion and, with a twisting or "screwing" motion, the cap of the lesion is entered. If subintimal passage is favored, as described by Bolia et al,[3] it is at this step that the wire is looped to purposely enter the subintimal space. We will limit this discussion to the technique to preferentially pass intraluminally.

Once the proximal tip of the wire enters the occlusion, it may naturally form a small loop at its tip. The goal at this stage is to maintain the width of the distal wire loop to remain smaller than or equal to the width of the native vessel (usually 5 mm to 6 mm wide for the SFA). As the loop traverses the occlusion, widening of the loop tip signifies more subintimal vessel dissection (Figure 3). In my opinion, the success of reliable re-entry into the distal vessel diminishes as the loop size increases. To reshape the tip into a smaller configuration, push the support catheter over the unlooped segment of the Glidewire and pull the wire back into the catheter to straighten the tip. Once restraightened, re-engage the occlusion with the wire tip using the twisting motion previously described to enter the proximal nub. Once again, form a small loop and push toward the recanalization site more distally. This portion of the procedure requires road-map imaging to visualize the distal vessel. Angiographic imaging through the support catheter will be both unhelpful and visually nonappealing. The contrast will stain the subintimal space and obscure visualization, and should be limited, if done at all.

Figure 3. An example of the Glidewire loop becoming too wide.

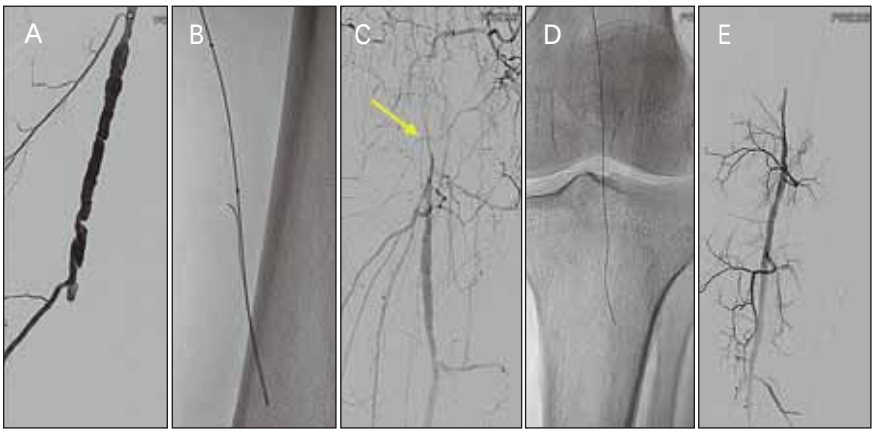

Figure 4. An example of distal popliteal artery recanalization with a .014-inch wire. Occluded left SFA (A). A .035-inch Glidewire subintimal dissection proximal to the popliteal artery (B). Re-entry with a .014-inch Abbott Confianza wire (C,D). Confirmation angiogram of the distal tibioperoneal artery after successful wire crossing (E).

Once the distal reconstitution site is seen under angiographic road map imaging, the support catheter is advanced to the segment just proximal to the patent vessel. There are times when the 4-F or 5-F catheter gets trapped in the subintimal channel and will not follow the hydrophilic wire. Be prepared to downsize the support catheter to a .035-inch compatible catheter, such as the Spectranetics Quickcross catheter (Spectranetics Corporation, Colorado Springs, CO). It is rare that a wire with less support will be of assistance at this point. However, we may choose the V-18 .018-inch Control Wire (Boston Scientific Corporation, Natick, MA), or less often a .014-inch stiff, but steerable coronary wire such as the Abbott Asahi wires, the Confianza (Abbott Vascular, Redwood City, CA), or the Persuader wire (Medtronic Vascular, Santa Rosa, CA) (Figure 4). Either way, the re-entry into the distal true lumen should be done like the ostial entry into the occlusion. The wire should be restraightened and passed into the distal vessel under direct visualization. Once satisfied that the wire is moving freely in the distal vessel, advance the support catheter into the distal segment, past the occlusion, and image with a diluted contrast injection into the distal vessel for confirmation of successful recanalization. Do not continue to create a more distal subintimal channel with more dissection if the catheter does not appear to be in the true lumen at this point. This is where re-entry devices are utilized. Further dissection with the Glidewire would lead to progressive subintimal channel creation, reducing the likelihood of successful true lumen re-entry. In addition, the need for more stents and distal stents may reduce the long-term success of long-segment SFA recanalization. Even more important is the progressive dissection below the knee compromising important distal collaterals and potentially worsening claudication symptoms.

If successful intraluminal re-entry into the distal reconstitution site of the SFA is not achieved, a re-entry device is a consideration for completion of the case. Remember, a 7-F sheath will be necessary for most of these devices. Once a contralateral sheath is in place, either the Pioneer catheter (Medtronic Vascular) or the Outback (Cordis Corporation, a Johnson & Johnson Company, Miami, FL) can be used.

SafeCross Wire

The SafeCross wire (IntraLuminal Therapeutics, Menlo Park, CA) has the unique property of an optical coherence reflectometer. This wire is coupled with radiofrequency energy that is delivered from the tip if the reflective signal obtained by the near-infared sensor identifies a luminal position, signified by a green indicator. Radiofrequency is not deliverable if the reflective signal is red, suggesting wire proximity to the endoluminal wall. The benefit of this technology is the theoretical advantage of remaining in the intraluminal space, thus reducing the dissection plane of a long occlusive lesion. Certain anatomical situations

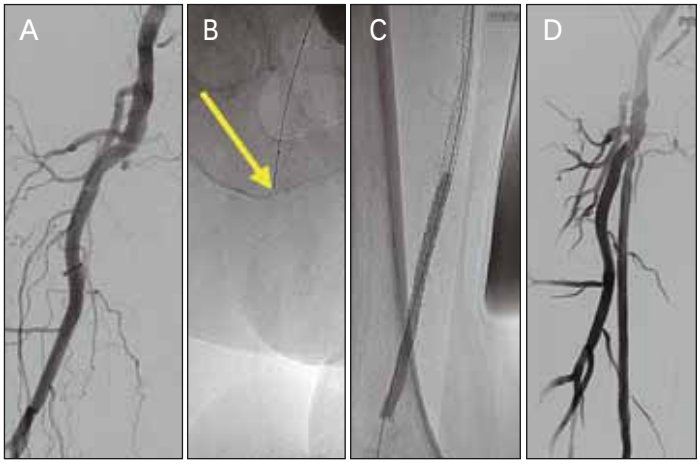

Figure 5. An occluded ostial SFA with a small stump (A). An .018-inch SafeCross radiofrequency wire penetrates the proximal cap (B). Standard PTA and stent therapy (C). Final angiographic result (D).

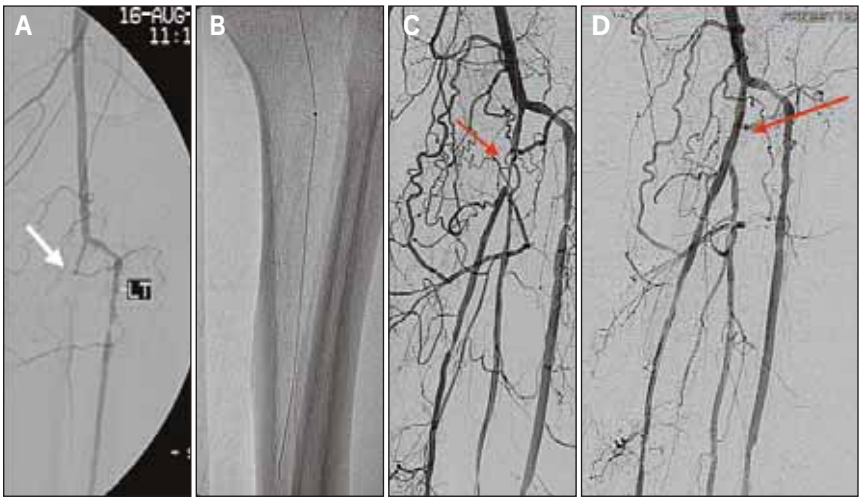

Figure 6. A diffuse, occluded tibioperoneal artery (A). A .9-mm laser uncovers the patent distal vessel (C). Final angiographic result (D).

favor its use (Figure 5). A flush occlusion of the SFA with no visible nub, occlusions across the knee joint, and occlusions at the site of a prominent collateral channel are three clinical scenarios in which intraluminal passage may produce greater success. Clinical success was identified in a registry when compared to standard glidewire alone for CTOs in the SFA. SafeCross wire was proved to have clinical benefit for increasing successful wire passage in failed SFA occlusions after standard glidewire technique.[4]

Excimer Laser

Many long occlusions of the SFA are composed of a focal proximal cap followed by a long segment of gelatinous debris culminating in a distal fibrous cap. Once the proximal cap is crossed either with a guidewire or another device, it may be advantageous to directly interact with the platelet and coagulated material. Excimer laser of the 308-nm wavelength (Spectranetics) has a direct effect on platelets by reducing their aggregation.[5] This clinical benefit of uncovering the true lesion in a long occlusive segment of the SFA may significantly reduce stent placement.[6] We often use excimer laser angioplasty to identify the culprit segments of SFA and tibioperoneal disease, which are then locally stented if necessary (Figure 6).

Blunt Microdissection

The Frontrunner catheter (Cordis Corporation, a Johnson & Johnson Company, Miami, FL) is a blunt microdissection device that takes advantage of the elastic properties of adventitia versus inelastic properties of fibrocalcific plaque to create fracture planes. This technique may be advantageous in penetrating hard fibrous caps of the SFA occlusions (Figure 7). The device separates atherosclerotic plaque in various tissue planes, creating a passage through the CTO.[7]

RE-ENTRY CATHETERS

The Pioneer Catheter

The Pioneer device is a 6.2-F catheter with two wire ports, each .014-inch compatible, one with a hollow core nitinol needle that is guided by an integrated 64-element, phased-array intravascular ultrasound device and is connected to a Volcano (Volcano Corporation, Rancho Cordova, CA) IVUS console, enabling vessel imaging (Figure 8). The device is delivered through the subintimal plane and is placed with the distal tip at the level of the SFA re-entry site. By slowly rotating the catheter, the ultrasound image is maneuvered until the

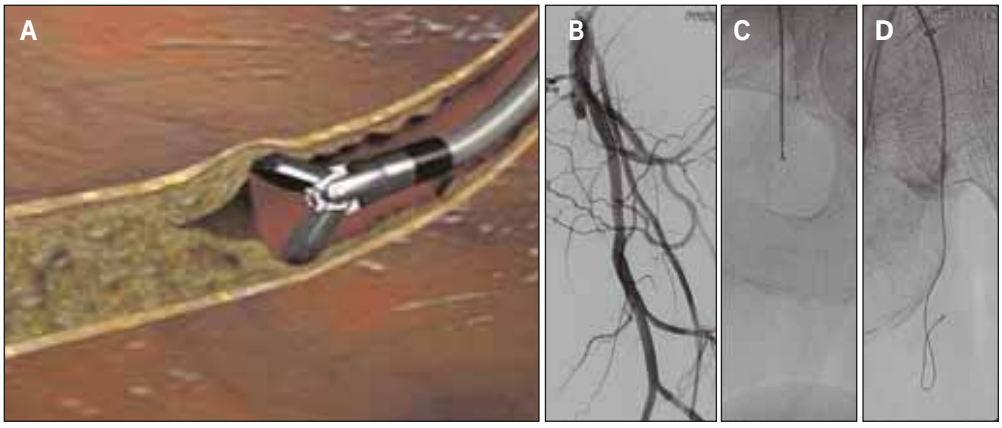

Figure 7. Example of Frontrunner catheter blunt microdissection (A). An occluded left SFA with hard proximal stump (B). The Frontrunner catheter penetrates cap (C). Standard looped subintimal wire dissection follows (D).

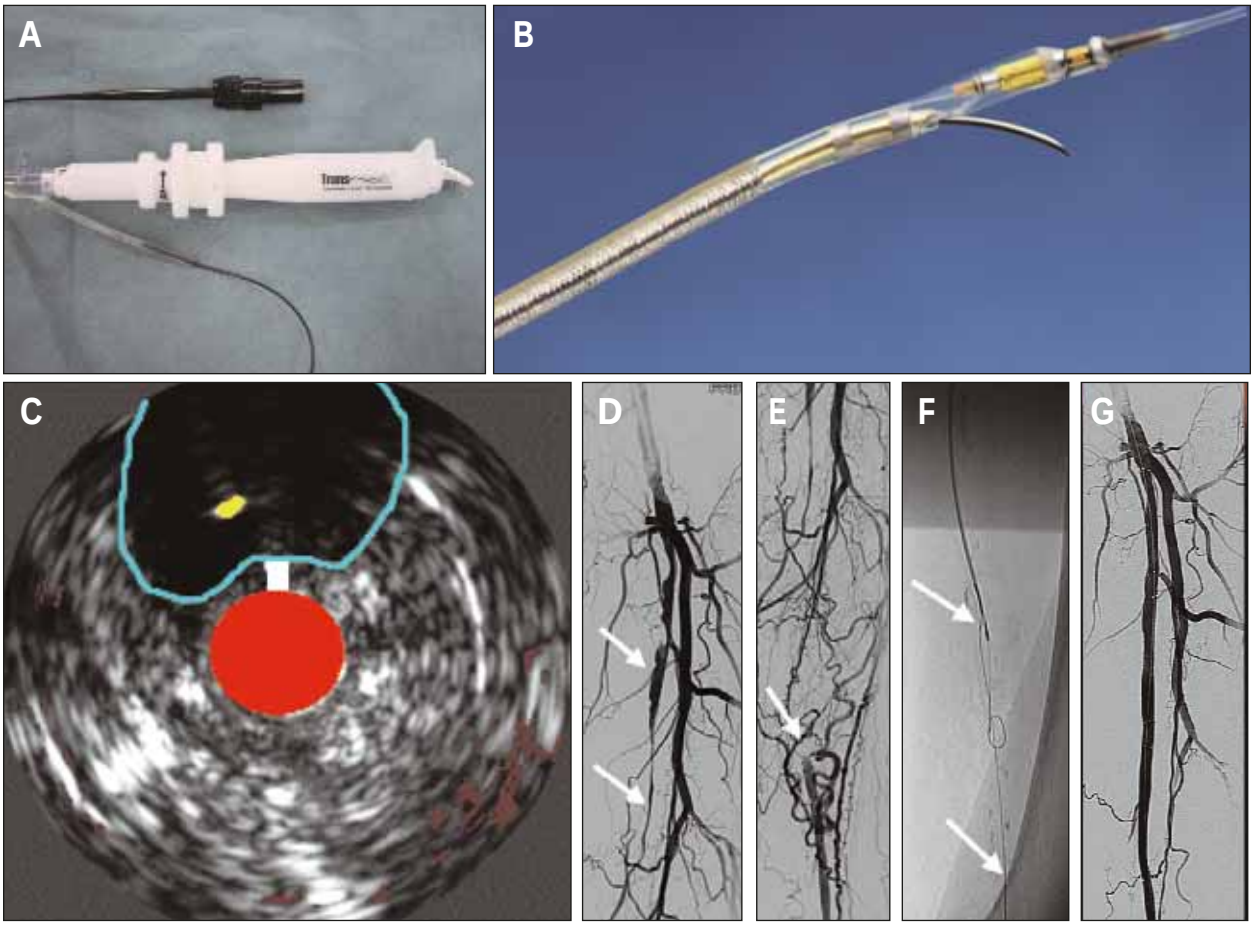

Figure 8. Example of the Pioneer re-entry catheter. Handle of Pioneer catheter with variable depth nitinol needle for re-entry (A, B). Ultrasound image with catheter oriented toward the true lumen at 12-o'clock position (C). Occluded left SFA (D). Distal reconstitution of SFA at the adductor canal (E). Image of the Pioneer catheter and successful re-entry into the true lumen (F). Final angiographic result (G).

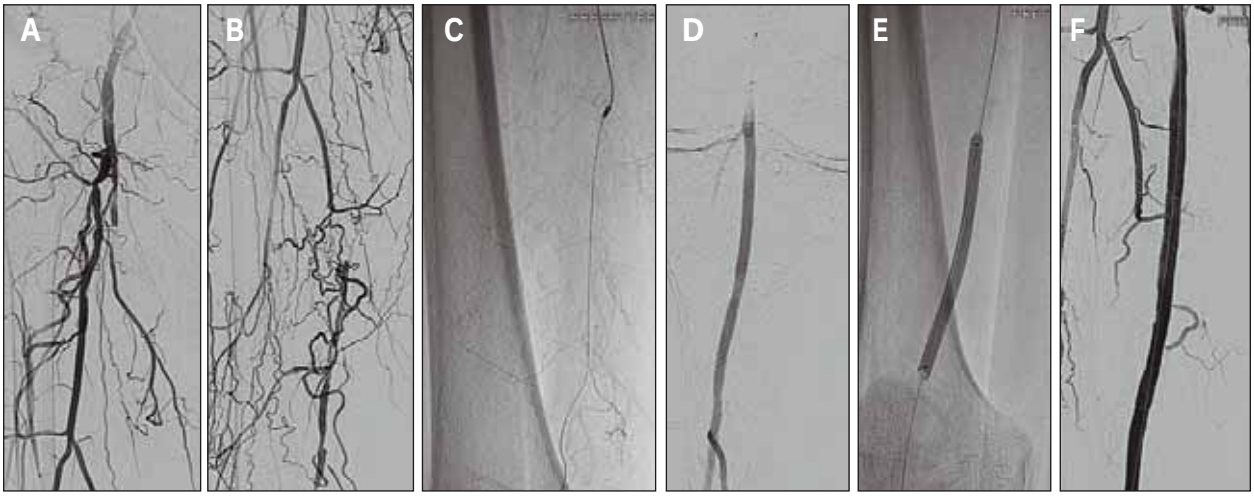

Figure 9. Example of the Outback catheter re-entry. Occluded right SFA (A). Distal reconstitution at the adductor canal (B). The Outback catheter re-enters distal true lumen after 90° orthogonal views confirm needle position (C). Angiographic confirmation of the distal true lumen (D). PTA and stent therapy (E). Final angiographic result (F).

Figure 10. The original Outback Catheter design (A). The new locate, tune, and deploy Outback catheter design (B).

tip of the nitinol needle is oriented toward the true lumen and is lined up at the 12-o'clock position on the ultrasound image (Figure 8C). The needle is plunged into the lumen at a controlled depth, typically between 3 mm to 5 mm. The soft-tipped, nonhydrophylic, .014-inch floppy-tipped wire in the monorail port of the catheter is sent through the needle into the distal vessel and is confirmed with angiography. The catheter is carefully removed without pulling out the re-entry wire and routine intervention is performed. Difficulty in successful re-entry is encountered with highly calcified vessels, poorly visualized distal reconstitution, deep subintimal catheter location, and poor wire angle of the floppy wire. Early successful experience with this catheter in a limited patient population has led to more widespread use.[8,9]

The Outback Catheter

The Outback catheter (Cordis), used for re-entry (Figure 9), is a 6-F compatible catheter with a hollow 22-gauge cannula for distal vessel entry using fluoroscopic imaging (Figure 10A). The device is delivered to the distal subintimal space adjacent to the reconstitution of the vessel and two orthogonal angiographic views are taken. The proprietary locate, tune, and deploy technique is used to increase successful distal re-entry (Figure 10B). An L-shaped fluoroscopic marker provides reproducible orientation of the tip toward the re-entry target site. The "T"une fluoroscopic marker, combined with a 90° orthogonal view, confirms the desired alignment to fine tune positioning at the target re-entry site. Lastly, the 22-gauge, nitinol re-entry cannula is plunged into the distal vessel to re-enter into the true lumen. As with the other devices, early experience was favorable and thereby encouraged more recent use.[10]

CONCLUSION

Complex CTOs require patience, tools, technique, and experience. New technologies, including blunt microdissection and re-entry catheters with and without IVUS, have greatly enhanced our success of crossing long-segment SFA occlusions. In addition to traditional low-tech but successful use of guidewire technology, these luminal re-entry devices have created options to reduce distal propagation of subintimal dissection planes. The clinical and technical success of CTO therapy has now opened the door to innovative solutions to develop devices to maintain long-term patency in even the most complex SFA occlusions. ■

Tony Das, MD, is Director, Peripheral Vascular Interventions at the Presbyterian Heart Institute in Dallas, Texas. He has disclosed that he is on the advisory boards of Cordis, Guidant, Medtronic, ev3, Boston Scientific, and Spectranetics. Dr. Das may be reached at tdas@civadallas.com.

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