



Transcollateral Intra-Arterial Retrograde Ostial Superficial Femoral Artery Chronic Total Occlusion Recanalization for Critical Limb Ischemia

Sehrish Memon, MD; Jon C. George, MD; Sanjog Kalra, MD; Sean F. Janzer, MD

Abstract

Transcollateral intra-arterial (TCIA) technique for peripheral chronic total occlusion (CTO) recanalization has advantages over transpedal access in critical limb ischemia (CLI) or drug-refractory symptomatic peripheral artery disease (PAD). Specifically, the strategy avoids the need for alternative pedal access, especially in those with single patent tibial vessel; avoids potential damage to “no stent zone” segments, such as bifurcations with decreased re-entry options; improves patient comfort by avoiding repositioning patients for popliteal access; and augments procedural efficiency when alternative access site is unprepared. Knowledge and experience with the coronary hybrid algorithm can facilitate the use of the TCIA approach for treatment of complex PAD anatomy in a time-efficient manner. Additionally, safety and feasibility can improve by integrating the coronary CTO skillset, such as treatment of perforation with coils, fat embolization for the treatment of peripheral collateral perforation, and the use of dual-lumen microcatheters for special indications. We present a case of ostial superficial femoral artery CTO in a patient with CLI who underwent successful revascularization via TCIA strategy with a successful outcome.

J CRIT LIMB ISCHEM 2021;1(2):E73-E78. Epub 2021 May 7.

Key words: chronic total occlusion, critical limb ischemia, endovascular intervention, transpedal approach

Transcollateral intra-arterial (TCIA) retrograde approach is uncommonly employed by peripheral chronic total occlusion (CTO) operators in comparison with retrograde transpedal route. In contrast, retrograde CTO percutaneous coronary intervention (PCI) continues to evolve, with improvements in device technology and operator experience. In a multicenter Japanese registry of 801 patients undergoing retrograde CTO-PCI, technical success rate was 85% and clinical success rate was 84%.⁹ Contemporary retrograde CTO-PCI studies report efficacy and safety similar to the antegrade approach. A single-center Taiwanese registry of 321 consecutive patients reported similar technical success rate (97.4% vs 96.4%; $P=.75$), complication rate (2% vs 3.6%; $P=.51$), and major adverse cardiac event rate (0.7% vs 0.6%) when comparing antegrade vs retrograde approach for CTO-PCI, respectively.¹⁰

While there are no data comparing the benefit of TCIA vs transpedal strategy for retrograde peripheral CTO recanalization, greater operator experience with the latter may hinder the use of the TCIA approach as a first-line strategy. The following case

report serves as a backdrop to examine the benefits and risks of one strategy vs the other, and demonstrates the integration of multiple coronary retrograde PCI techniques for TCIA-CTO recanalization.

Case Example

A 69-year-old woman with coronary artery disease, atrial fibrillation, congestive heart failure, peripheral artery disease (PAD), and left above-the-knee amputation presented with right lower-extremity rest discomfort, consistent with Rutherford class IV symptoms. At baseline, she utilized a left leg prosthesis and was ambulatory around the house, but used a wheelchair for strenuous outdoor activities. Physical examination revealed monophasic right dorsalis pedis and posterior tibialis pulses by Doppler without erythema, rash, or ulcers. A right lower-extremity ankle-brachial index in the outpatient setting was noted to be 0.43; thus, a peripheral angiogram with possible intervention

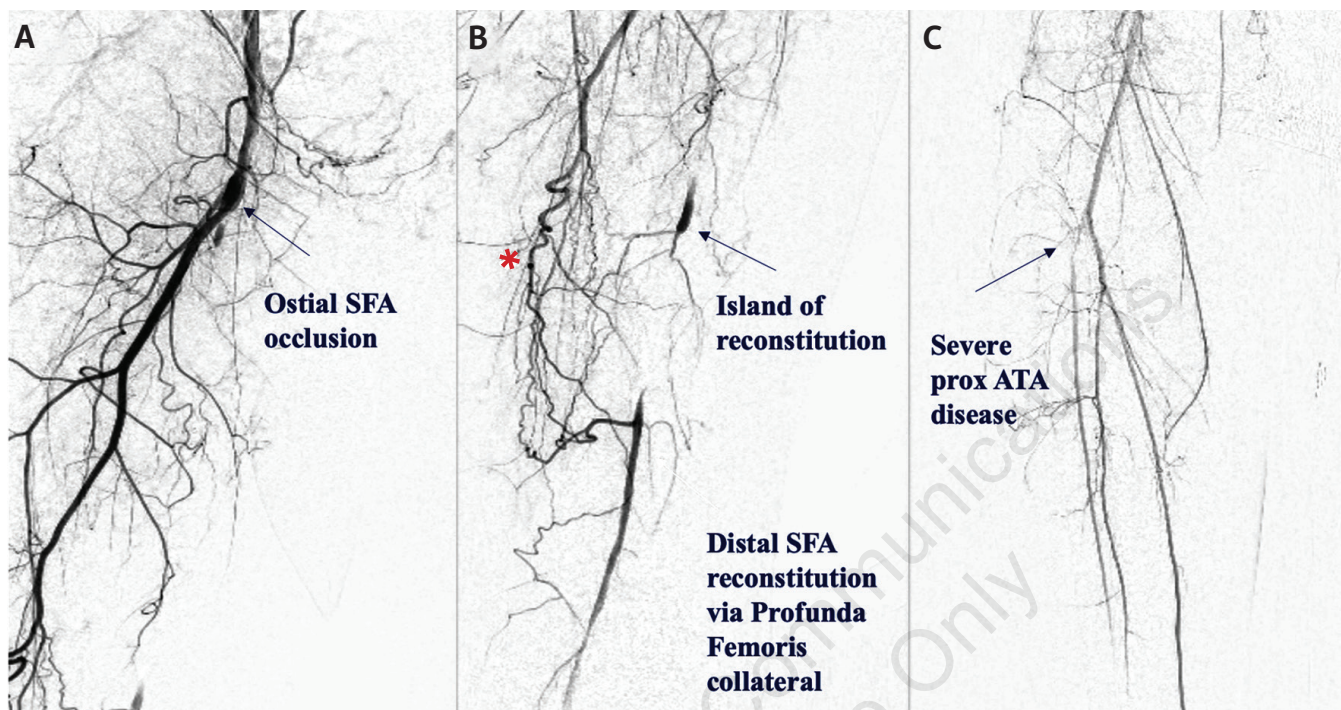


FIGURE 1. Diagnostic peripheral angiogram. (A) Ostial superficial femoral artery (SFA) chronic total occlusion. (B) Island of reconstitution at mid SFA (blue arrow) and distal SFA complete reconstitution (blue arrow) via profunda femoris artery collaterals (*). (C) Severe proximal anterior tibial artery (ATA) disease.

was planned. Pertinent outpatient medical therapy included clopidogrel 75 mg, apixaban 5 mg twice daily, and atorvastatin 80 mg nightly.

A 6 Fr left common femoral artery (CFA) retrograde access was obtained with placement of a 55 cm Flexor Ansel guiding sheath (Cook). Diagnostic peripheral angiogram showed ostial superficial femoral artery (SFA) CTO with an island of reconstitution at the mid SFA and complete reconstitution at the distal SFA via profunda femoris artery (PFA) collaterals (Figures 1A and 1B). Below the knee, imaging demonstrated severe proximal anterior tibial artery (ATA) disease (Figure 1C). Due to ostial SFA-CTO cap ambiguity and unprepped transpedal access, retrograde recanalization using the TCIA approach via PFA collaterals was opted. The first collateral channel (CC) for retrograde wire escalation was unsuccessful and selective CC angiogram via microcatheter showed multiple acute bends and 360° loops (Figure 2A). The second collateral was significantly straighter, with no acute bends or loops, and thus was traversed over a 0.014" platform microcatheter with Suoh guidewire (Asahi Intecc) with subsequent successful distal CTO cap crossing with Astato stiff guidewire (Asahi Intecc) (Figures 2B and 2C). However, the retrograde Astato wire entered the subintimal space and was exchanged for a polymer-jacketed hydrophilic Fielder XT guidewire (Asahi Intecc), which was left looped proximal to the CFA bifurcation (Figure 2D). Next, antegrade wire escalation

(AWE) was initiated with the Fielder XT guidewire through a microcatheter using the retrograde wire as a guide. This wire also entered the subintimal space in a looped fashion (Figure 2E). After confirming close proximity of the subintimal retrograde and antegrade guidewires with C-arm rotation under fluoroscopy (Figure 2F), preparation was made to initiate reverse controlled antegrade and retrograde tracking (CART). A 4.0 x 100 mm balloon was taken over the antegrade guidewire and inflated with subsequent crossing of the retrograde wire into the CFA true lumen upon balloon deflation (Figures 3A and 3B). After multiple failed attempts at retrograde free-wiring into a guide sheath, a 10 mm gooseneck snare was introduced through the guide sheath for wire externalization (Figure 3Ca). Inadvertent detachment of the retrograde wire from the snare in the mid guide sheath was resolved with introduction of a Caravel microcatheter (Asahi Intecc) over the retrograde wire into the antegrade sheath, which provided increased support for guidewire manipulation, with subsequent use of the "mother-in-daughter sheath" technique. With this technique, a 4 Fr, 10 cm sheath was fed into a 6 or 7 Fr guide sheath, allowing easy entry of the retrograde externalization guidewire (R350 guidewire; Vascular Solutions) directly into the 4 Fr sheath, which was visible after removal of the 4 Fr sheath from the 7 Fr guide sheath (Figure 3Cb). To ensure vessel access past the distal CTO cap without losing wire access, a Twin-Pass dual-lumen microcatheter (Teleflex) was taken into the PFA

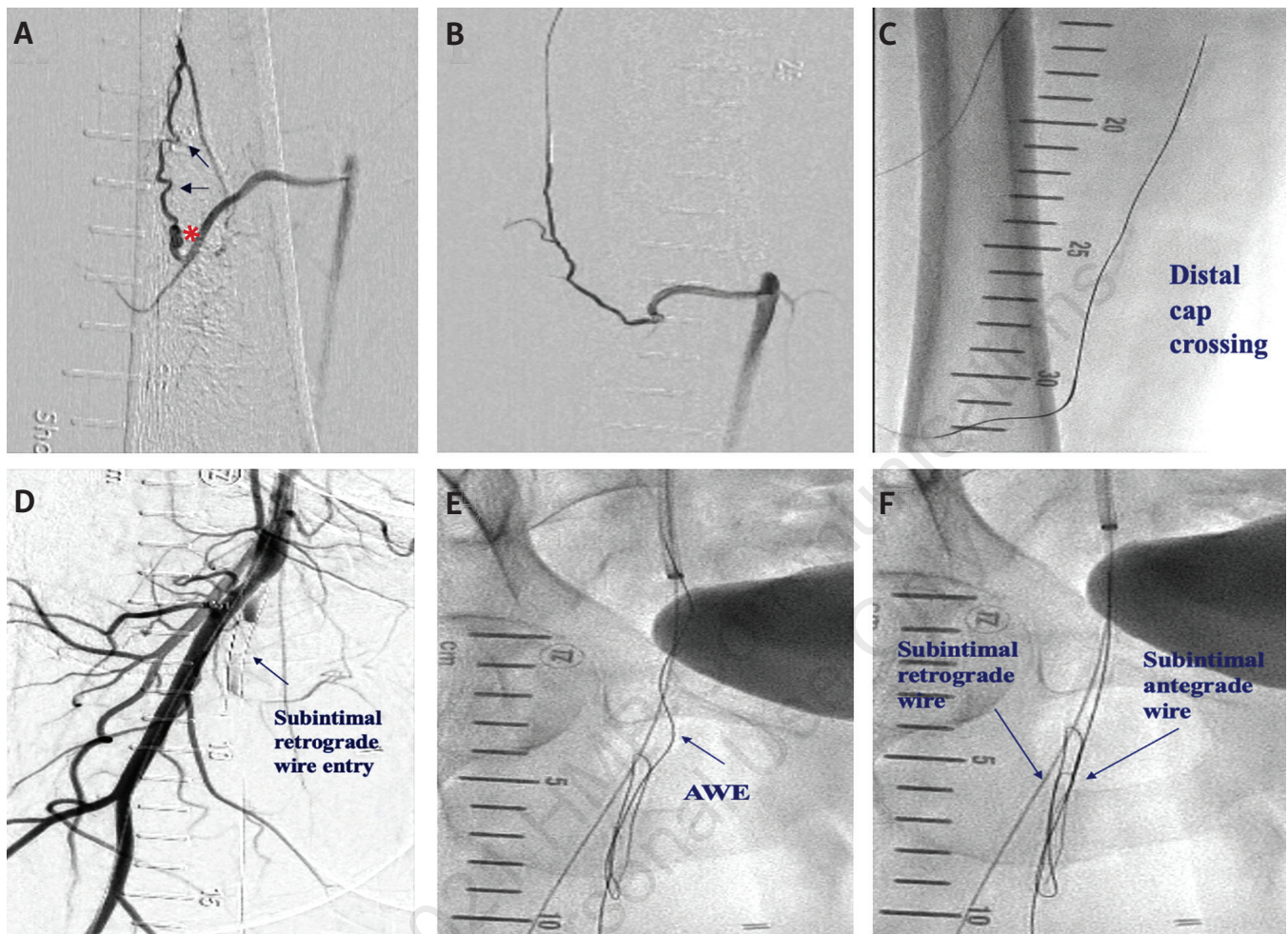


FIGURE 2. (A) Failed attempt at transcatheter crossing of the initially selected collateral. Selective microcatheter injection showed multiple acutely angled ends (arrows), in addition to multiple 360° loops (*). (B) Selective angiogram of the second selected collateral showed a straighter collateral with higher likelihood of successful crossing. (C) Retrograde wire escalation via the second collateral resulted in successful distal chronic total occlusion (CTO) cap crossing. (D) Retrograde polymer-jacketed hydrophilic wire entered subintimal space with distal loop (arrow) proximal to the common femoral artery bifurcation. (E) Antegrade wire escalation (AWE) was initiated, but also entered the subintimal space in a looped fashion. (F) Both retrograde and antegrade wires in the subintimal space, as depicted.

collateral for wire entry into the distal SFA through the side port (Figure 3D). Next, a microcatheter was taken antegrade over retrograde externalized R350 wire to the point of the Twin-Pass microcatheter, with subsequent removal of the R350 guidewire. Then, the distal SFA was successfully wired with a new antegrade guidewire through the antegrade microcatheter (Figure 3E). Care was taken to remove the externalized R350 wire before removing the Twin-Pass microcatheter to avoid unprotected CC injury from wire shear stress. Predilation was performed with a 5.0 x 120 mm Mustang balloon (Boston Scientific) and the SFA was subsequently stented with a 5.5 x 150 mm, self-expanding, bare-metal Supera stent (Abbott Vascular) distally overlapped with a 6.0 x 60 mm Everflex stent (eV3) proximally (Figure 4A). Postdilation was accomplished with a 6.0 x 120 mm Mustang balloon (Figure 4B).

Final result showed brisk flow in the entire SFA and tibials into the pedal circulation (Figures 4B-4D). Bounding dorsalis pedis and posterior tibialis pulses were palpable over the right lower extremity at the conclusion of the procedure.

Discussion

Algorithms and scoring systems for infralingual CTO recanalization for symptomatic PAD have been established to increase the success rate of revascularization. Banerjee et al described an infrainguinal CTO crossing algorithm with anatomic consideration of proximal and distal cap morphology, incorporation of endovascular ultrasound, wire-escalation strategy, and inclusion of CTO crossing and re-entry devices.¹ A retrospective study of 150

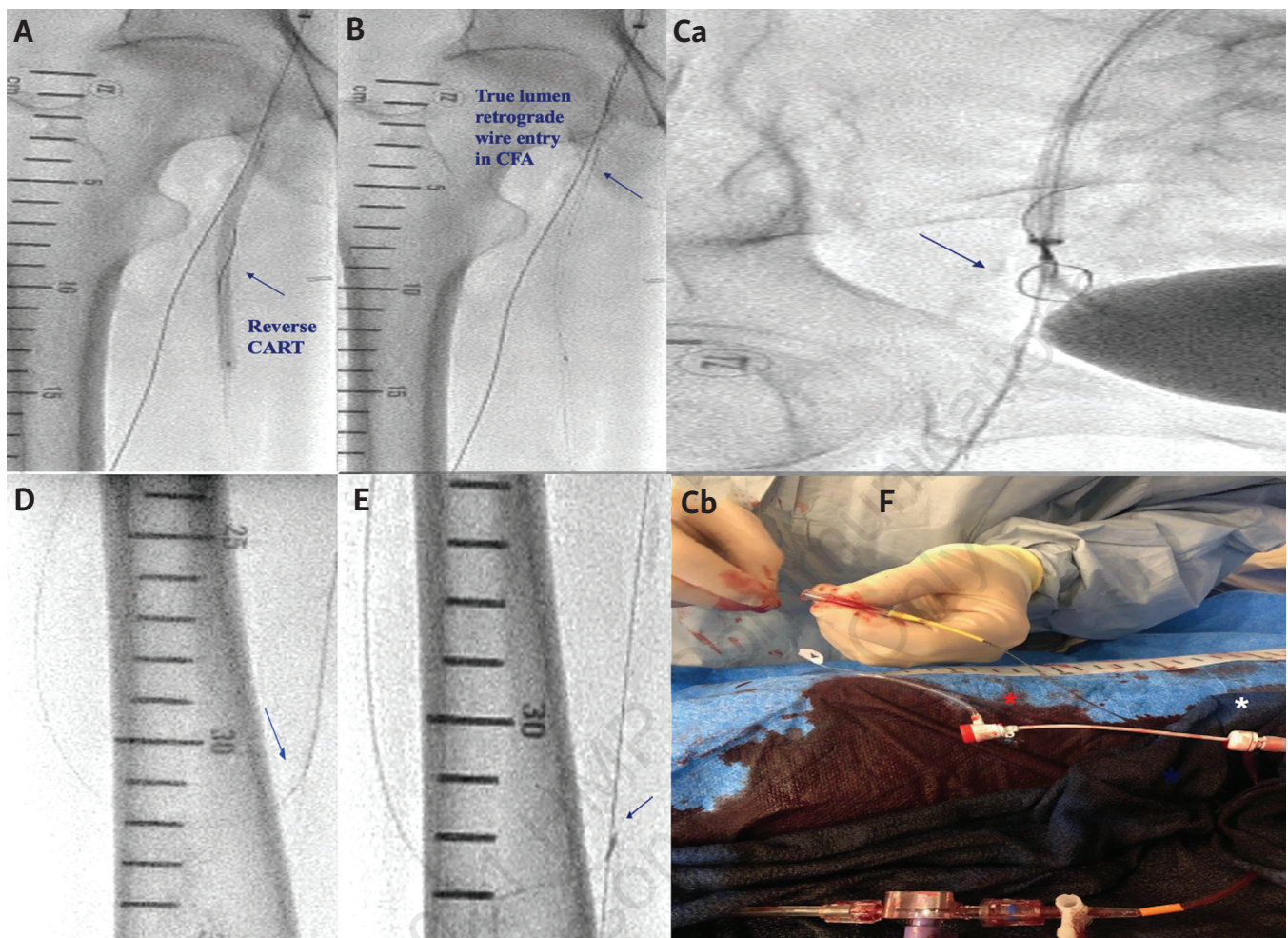


FIGURE 3. (A) Reverse controlled antegrade and retrograde tracking (CART) initiated with a 4.0 x 100 mm balloon over antegrade wire. (B) Common femoral artery (CFA) true lumen entry of retrograde wire (arrow) after antegrade balloon deflation. (Ca) Retrograde wire externalized via antegrade 10 mm gooseneck snare device. (Cb) Inadvertent detachment of guidewire at mid guide sheath resolved with use of Caravel microcatheter (Asahi Intecc) over retrograde wire into antegrade sheath and use of mother-in-daughter sheath technique; (4 Fr sheath [red*] into 7 Fr sheath [white*]) with exchange of retrograde wire for R350 guidewire (Teleflex) and externalization through 4 Fr sheath. (D) Twin-Pass dual-access microcatheter (Teleflex) into profunda femoris collateral for distal superficial femoral artery (SFA) wire entry through side port, ensuring distal CTO cap crossing without losing wire access. (E) A new antegrade microcatheter taken over externalized retrograde wire until the Twin-Pass catheter (arrow), with successful wiring into distal SFA with an antegrade guidewire.

patients with SFA-CTO had 59% antegrade CTO crossing success rate, which increased to 85% when alternative retrograde access was utilized based on the FACTOR scoring system.² The coronary hybrid algorithm was the first to organize the steps in order to increase both procedural efficiency and success rate when attempting coronary CTO-PCI. Within this algorithm, ambiguous proximal cap, poor distal target, and appropriate “interventional” collaterals all favor a primary retrograde approach.³ Additionally, the experienced authors emphasized the fluidity of the algorithm, emphasizing that no more than 5-10 minutes should be spent in a stagnant approach and encouraging change of wire, microcatheter, and or wire/device strategy.³ While retrograde

collaterals are commonly utilized in coronary CTO-PCI, they are rarely undertaken in infrainguinal CTOs.

Transpedal artery access is the predominant retrograde approach utilized by infrainguinal CTO operators. In an observational study over 14 months, antegrade failure rate of 17.8% was seen in 343 limbs, of which 82.2% were appropriate for retrograde approach and transpedal access was utilized in 45 limbs (88.2%), whereas TCIA technique was used in 6 limbs (11.8%).⁴ Operator experience, appropriate patient anatomy, and the pros and cons of each strategy must be fully comprehended before embarking upon either approach. In an observational analysis comprising 10 studies (881 patients) where transpedal access was utilized,



FIGURE 4. (Aa) Superficial femoral artery (SFA) stented with a 5.5 x 150 mm Supera self-expanding bare-metal stent (Abbott Cardiovascular) distally overlapped with a 6.0 x 60 mm EverFlex self-expanding bare-metal stent (Medtronic) proximally after adequate predilation. (Ab) Postdilation with a 6.0 x 120 mm Mustang balloon (Boston Scientific). (B, C) Final angiographic result of proximal to distal SFA. (Da) Below-the-knee flow. (Db) Pedal flow.

68.4% had critical limb ischemia (CLI), with 93.7% having complex CTOs. The revascularization success rate was 92.6%, with dissection as the most common complication (7.49%), followed by perforation (1.36%) and embolization (1.25%).⁵ Major complications during acute pedal access-site closure are rare (1.9% in the aforementioned study).⁴ Risk vs benefit must be taken into consideration before attempting transpedal access, especially in CLI patients with a single remaining patent tibial vessel, making TCIA access more appealing. Additionally, the advancement of balloons, stents, or atherectomy devices may be limited based on pedal artery luminal size, tortuosity, and calcification.

TCIA retrograde access can be advantageous and preferable in the setting of a single remaining patent tibial vessel, subintimal wire entry in “no stent zone” segments (such as bifurcation segments where re-entry is not favorable), avoidance of patient repositioning such as proning position for popliteal artery access, and improvement of procedural efficiency when alternative access site is unprepared. While the complication rate of popliteal retrograde access is low, cases of pseudoaneurysms and arteriovenous fistulas have been reported on duplex examinations.⁶ Furthermore, in patients where the single patent tibial vessel is the peroneal artery, transcollateral access may be a more attractive option, as peroneal access is often anatomically difficult to obtain

and maintain hemostasis. Collateral angulation, tortuosity, size, risk of perforation, and acute closure in CLI patients are important factors to consider prior to undertaking the TCIA approach. Finally, experience with transcollateral access has shown that, just as with transpedal access, the distal CTO cap is not breached outside the true lumen, thereby reducing the risk of distal dissection.

Integration of coronary CTO-PCI devices and techniques used for retrograde approach can be instrumental in achieving high success rates for TCIA retrograde CTO recanalization. For example, operators should utilize the Werner classification of CC, namely: CC0 = no continuous connection between collateral supplying and receiving vessel; CC1 = thread-like continuous connection; and CC2 = sidebranch-like connection, where CC1 and CC2 should be the collaterals chosen.⁷ Additionally, acute angulation, corkscrew morphology, branching, and calcification can increase CC navigation challenges. Selective CC microcatheter injection, as employed in the present case, can allow the selection of the CC with the highest success rate. Furthermore, advancements in coronary guidewire technology to include specialized guidewires for CC navigation, such as the Suoh guidewire, can further improve procedural efficiency. Subintimal retrograde wire entry close to the “no stent zone” (the CFA bifurcation in this case) allowed the quick switch of strategy to

AWE, but as the antegrade wire also gained subintimal entry, methodical employment of reverse CART allowed successful retrograde wire true lumen entry.

Dual-lumen microcatheters, such as the Twin-Pass, which feature a rapid exchange and over-the-wire port, allow sidebranch access in complex bifurcations PCI with angulated sidebranch, parallel wiring technique in CTO-PCI, selective injection to alleviate anatomic ambiguity, and sidebranch CTO wiring with the sidebranch close to the proximal cap, all of which are accomplished through the side-port lumen.⁸ The dual-lumen catheter used in this case ensured safe wire access past the distal CTO cap, which was accomplished through the side port and avoided loss of guidewire position. Wire externalization is another important aspect to retrograde CTO recanalization via TCIA access, as direct wire entry into the guide sheath can be challenging and in such cases snaring devices can be successfully applied. In the present case, inadvertent detachment of the guidewire from the snaring device half-way within the guide sheath was easily resolved by feeding another low-profile microcatheter through the CC into the guide sheath to increase guidewire support and allow wire externalization via the sheath hub. Although some guide sheath hubs can be screwed off to allow easy wire externalization from the sheath, this capability is lacking in other guide sheaths. As such, the novel strategy of the “mother-in-daughter sheath” technique, as described above, allows easy wire exit. Finally, coronary CTO techniques can be used to manage peripheral collateral complications; for example, fat embolization can be used to manage peripheral collateral perforation. The authors’ experiences with antegrade transcatheter perforations have shown that the majority are well tolerated and either close spontaneously or close with manual pressure applied to the thigh or with small low-profile balloon inflation.

Conclusion

TCIA retrograde approach can be safely applied for the recanalization of peripheral CTOs. The integration of coronary CTO skills and equipment, including management of complications, can improve operator efficiency and success rate with this technique.

References

- Banerjee S, Shishehbor MH, Mustapha JA, et al. A percutaneous crossing algorithm for femoropopliteal and tibial artery chronic total occlusions (PCTO algorithm). *J Invasive Cardiol*. 2019;31:111-119.
- Varghese V, Hassan HU, Lakhter V, et al. Femoral artery chronic total occlusion revascularization (FACTOR) score and algorithm: feasibility and validation in a single-center study of femoropopliteal occlusions. *J Invasive Cardiol*. 2020;32:E338-E348.
- Brilakis ES, Grantham JA, Rinfret S, et al. A percutaneous treatment algorithm for crossing coronary chronic total occlusions. *JACC Cardiovasc Interv*. 2012;5:367-379.
- Montero-Baker M, Schmidt A, Bräunlich S, et al. Retrograde approach for complex popliteal and tibioperoneal occlusions. *J Endovasc Ther*. 2008;15:594-604.
- Marmagkiolis K, Sardar P, Mustapha JA, et al. Transpedal access for the management of complex peripheral artery disease. *J Invasive Cardiol*. 2017;29:425-429.
- Dumantepe M. Retrograde popliteal access to percutaneous peripheral intervention for chronic total occlusion of superficial femoral arteries. *Vasc Endovasc Surg*. 2017;51:240-246.
- Werner GS. The role of coronary collaterals in chronic total occlusions. *Curr Cardiol Rev*. 2014;10:57-64.
- Oreglia JA, Garbo R, Gagnor A, Gasparini GL. Dual lumen microcatheters for complex percutaneous coronary interventions. *Cardiovasc Revasc Med*. 2018;19(3 Pt A):298-305.
- Tsuchikane E, Yamane M, Mutoh M, et al. Japanese multicenter registry evaluating the retrograde approach for chronic coronary total occlusion. *Catheter Cardiovasc Interv*. 2013;82:654-661.
- Lee CK, Chen YH, Lin MS, et al. Retrograde approach is as effective and safe as antegrade approach in contemporary percutaneous coronary intervention for chronic total occlusion: a Taiwan single-center registry study. *Acta Cardiol Sin*. 2017;33:20-27.

From the Division of Interventional Cardiology and Endovascular Medicine, Einstein Medical Center Philadelphia, Philadelphia, Pennsylvania.

Disclosure: The authors have completed and returned the ICMJE Form for Disclosure of Potential Conflicts of Interest. Drs Janzer, Kalra, and George report consultant income from Boston Scientific. Dr Memon reports no conflicts of interest regarding the content herein.

Manuscript accepted April 26, 2021.

The authors report that patient consent was provided for publication of the images used herein.

Address for correspondence: Sean F. Janzer, MD, Einstein Medical Center Philadelphia, 5501 Old York Rd, Philadelphia, PA 19141. Email: sjanzer@mac.com