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"Trans-Collateral" Angioplasty for a Challenging Chronic Total Occlusion of the Tibial Vessels: A Novel Approach to Percutaneous Revascularization in Critical Lower Limb Ischemia

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Arterial revascularization by means of percutaneous transluminal angioplasty (PTA) is a mainstay in the management of patients with peripheral artery disease and critical limb ischemia (CLI). However, when employing standard approaches, PTA of below-the-knee arteries may fail in up to 20% of cases. In the present article, we report a novel interventional strategy, the "transcollateral" angioplasty approach, which we successfully employed in a patient with critical lower limb ischemia and a challenging total infrapopliteal occlusion. This technique may probably increase success rates of PTA in very challenging total occlusions of below-the-knee arteries (e.g., those lacking a proximal occlusion stump). The tips pertinent to this case are illustrated, including the need to accurately choose appropriate guidewires and balloons, and the identification of the most appropriate collateral pathway. © 2008 Wiley-Liss, Inc.

Key words: collaterals; total occlusions; peripheral vascular disease

INTRODUCTION

Arterial revascularization by means of percutaneous transluminal angioplasty (PTA) is being increasingly used for the treatment of patients with severely symptomatic peripheral artery disease (i.e., those with critical limb ischemia (CLI)). This phenomenon has been largely dependent on technical and technological advancements, such as the introduction of dedicated low profile devices as well as the improvement due to subintimal angioplasty techniques.

While PTA for CLI has recently shown clinical results equivalent to those of the established standard of care, i.e., bypass surgery, percutaneous recanalization of below-the-knee occlusions can still be unsuccessful in up to 20% of patients, even in high-volume centers [1]. There is thus a need of adjunctive technical improvements for percutaneous revascularization of below-the-knee atherosclerotic disease. We hereby report a novel approach to recanalize challenging infrapopliteal total occlusions (i.e., those without a visible proximal occlusion stump): the ''transcollateral'' angioplasty approach.

CASE REPORT

A 63-year-old diabetic female, symptomatic in the previous month for rest pain in the right foot, with evidence of reduced transcutaneous oxymetry (<35 mm Hg) and echographic confirmation of an occlusion of the tibial vessels, was referred to our center for peripheral angiography and potential percutaneous revascularization. Antegrade common femoral artery approach was performed with a 6F 10-cm sheath (Terumo Medical Corp., Somerset, New Jersey). After the administration of 7,500 IU of unfractionated heparin intra-arterially, the diagnostic angiography was performed using the side arm of the introducer sheath.

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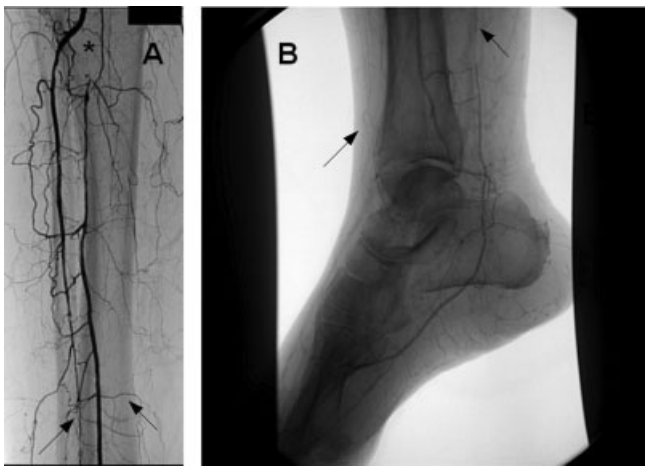

Fig. 1. The baseline angiography shows an occlusion of the anterior and posterior tibial arteries (arrows), with an occlusion of tibioperoneal trunk (*) (A, B).

Baseline angiography of the right lower limb disclosed an occlusion of the tibioperoneal trunk, a total occlusion of the posterior tibial artery, and additional occlusions of the distal anterior tibial artery and of the dorsalis pedis artery with a patent plantar branch (Fig. 1A and B) We decided to attempt percutaneous treatment of the first two occlusions and to avoid treatment of the last two. Given the lack of a visible proximal stump before the occlusions of the tibioperoneal trunk, and the presence of good collaterals (as evident from Fig. 2A), we decided to cross the occlusion of tibioperoneal trunk employing a retrograde approach, tracking the guidewire in the well-developed collaterals. We chose a 0.014 in. hydrophilic wire (Pilot 50, Guidant, Santa Clara, CA) and a 2.0-mm over-the-wire balloon (Amphirion, ev3, Plymouth, MN). Firstly, we crossed the occlusion of the tibioperoneal trunk in a retrograde manner (Fig. 2A–D) and predilated it (Fig. 3A). Secondly, leaving the ''loop'' wire in place as a marker, we approached the tibioperoneal trunk occlusion with another 0.014 in. wire (Choice PT, Boston Scientific, Natick, MA) and a 3.0-mm over-the-wire balloon (Amphirion). This second 0.014 hydrophilic wire was put in an antegrade way in the pathway created by the retrograde angioplasty (Fig. 3B). The angioplasty of tibioperoneal trunk was perfomed with a 3.0-mm balloon inflated for 3 min at a pressure of 14 atm (Fig. 3C). To recanalize the occlusion of the posterior tibial artery, which was also lacking a proximal stump after the angioplasty of tibioperoneal trunk, we engaged the collateral circulation from the peroneal artery to the posterior tibial artery with a 0.014 hydrophilic wire (Pilot 50) and a low profile over-the-wire balloon (Amphirion ev3, Plymouth, MN). (Fig. 4A and B). Employing the subintimal track and reentry (STAR) technique, we retrogradely recanalized the posterior tibial artery, but the balloon was unable to cross along pathway created by the wire (Fig. 4C). Leaving the ''loop'' wire in place as a marker, we then approached antegradely the posterior tibial artery occlusion with an additional 0.014 in. wire (Pilot 200, Guidant) and a 3.0 over-the-wire balloon (Fig. 4D). We were thus able to reach the true plantar branch, and we then completed angioplasty with prolonged (3 min) inflations at 16 atm pressure (Fig. 5A-C). The final result in the tibioperoneal trunk and in posterior tibial artery was satisfactory, without evidence of significant residual stenoses or flow limiting dissections (Fig. 6A-C). Femoral hemostasis was achieved with manual compression. The patient's subsequent hospital stay was uneventful, with persistence of palpable posterior tibial pulses and disappearance of pain. She was discharged on lifelong daily aspirin and ticlopidine for 1 month. After 7 months of follow-up, the patient was still pain-free at rest, with increased pain-free walking distance, and the duplex ultrasound scan demonstrated patency of both posterior and peroneal arteries.

DISCUSSION

While percutaneous recanalization appears equivalent to bypass surgery in the management of patients with critical lower limb ischemia [1], standard percutaneous approaches and techniques are still inadequate, as procedural failure can occur in up to one-fifth of the cases, even in experienced hands. In addition to the traditional controlateral approach, ipsilateral antegrade (i.e., femoral) and retrograde (e.g., pedal or posterior tibial) accesses and the ''pedal-plantar loop technique'' have been shown to be beneficial in increasing success rates, especially in the most challenging chronic occlusions [2–5]. Nonetheless, even these strategies may fail or prove unfeasible (e.g., when the distal vessels are also diseased).

In the present article, we provide details on a new approach to recanalize challenging below-the-knee chronic total occlusions, the ''transcollateral'' angioplasty technique. This technique is based on the creation of a loop with the guidewire from the peroneal to tibial vessels (ie between different tibial arteries) by means of guidewire tracking through collaterals. This loop can be used to directly open the artery from a retrograde approach (as in the first occlusion described in this case report) or also as a ''roadmap'' for further attempts to reopen antegradely the vessel (as in the second occlusion of this case report). We believe this technique may be of value specifically when a proximal occlusion stump is not evident, when a dissection flap or a perforation in the proximal tract of the target

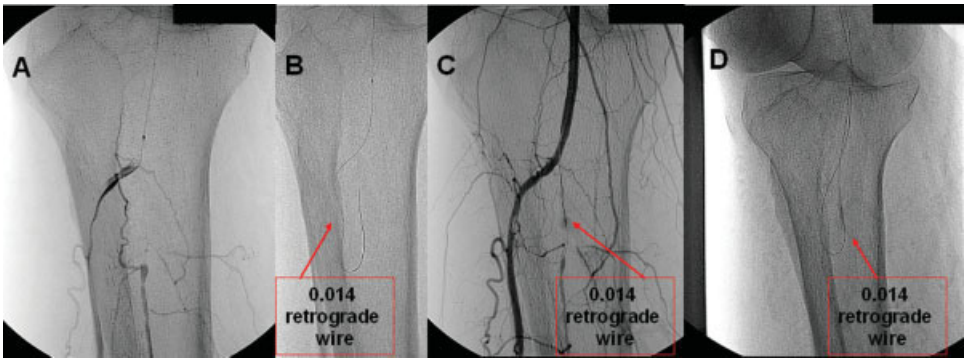

Fig. 2. Selective angiography of distal popliteal artery perfomed trough an OTW 2.0-mm balloon showed an absence of visible proximal stump of the occlusion of tibioperoneal trunk and a well developed collateral for the peronael artery (A). (B) The retrograde transcollateral approach at the occlusion of tibioperoneal trunk by means of an hydrophilic 0.014 wire and a 2.0-mm OTW balloon. The wire firstly engaged and crossed the collateral with the balloon support (arrows). (C, D) The wire crossed the occlusion of tibioperonal trunk in a retrograde fashion (arrows). [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

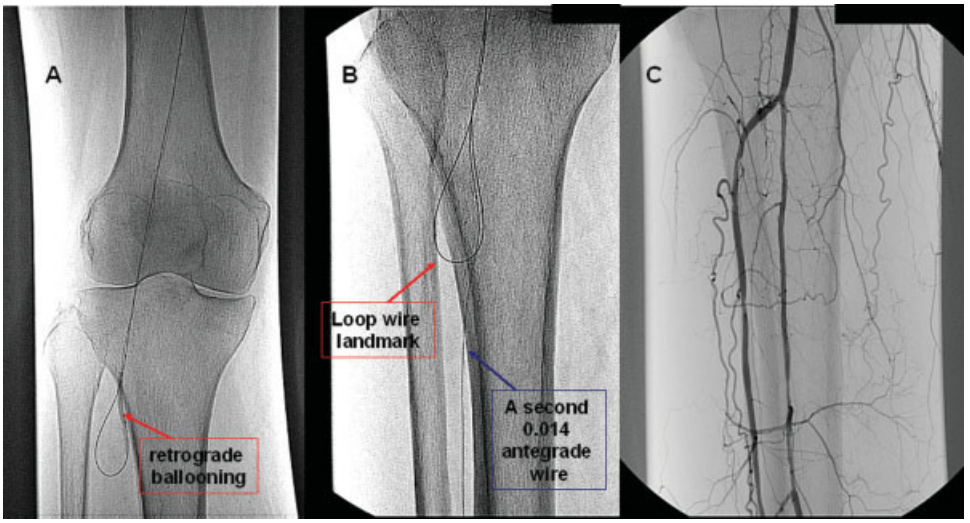

Fig. 3. (A) shows the retrograde ballooning of tibioperoneal trunk with a 2.0-mm OTW balloon. Leaving the loop wire in place as a marker, another 0.014 hydrophilic wire was put in an antegrade manner, trough the pathway created with retrograde angioplasty (B, arrows). (C) The result of the angioplasty of tibioperoneal trunk perfomed with a 3.0-mm over-the-wire balloon (arrow). [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

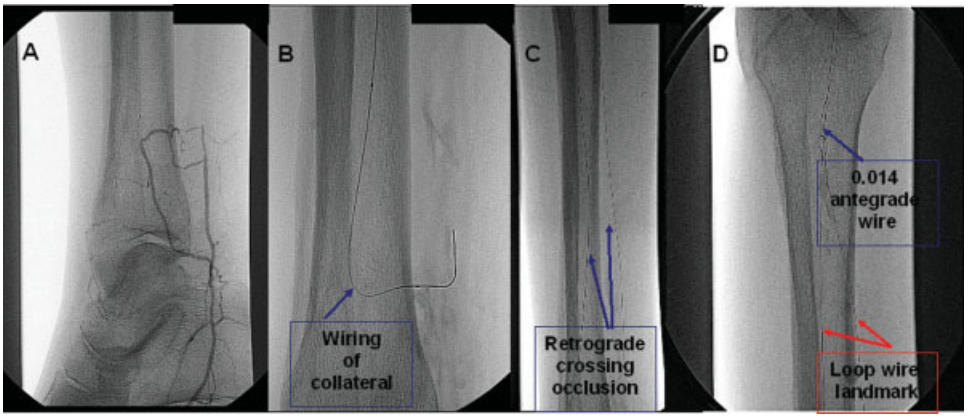

Fig. 4. (A) The selective angiography of collaterals from the peroneal to posterior tibial arteries. (B) The wiring of collateral with 0.014 hydrophilic wire and 2.0-mm balloon (arrow). Retrograde crossing of the occlusion of posterior tibial artery employing the STAR technique (C, arrows). Given the impossibility to cross a balloon retrogradely in the occlusion, we left the retrograde "loop" wire in place as landmark and with a second 0.014 hydrophilic wire the ostium of the posterior tibial artery was engaged (D, arrows). [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

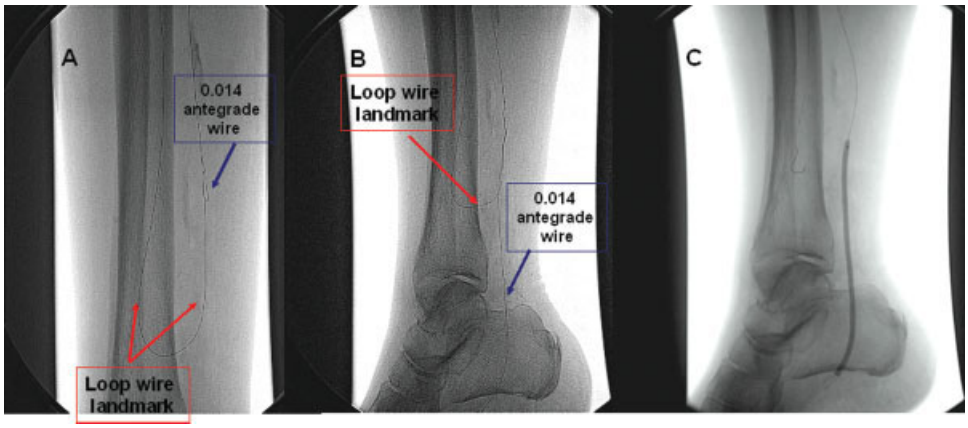

Fig. 5. (A) The loop wire placed retrogradely in the posterior tibial artery and the crossing, in an antegrade manner, of the second 0.014 hydrophlic wire with the support of a 3.0-mm OTW balloon. Employing the STAR technique the antegrade 0.014 wire reached the true lumen of the plantar branch (B, arrows). The angioplasty was perfomed with a the 3.0-mm OTW balloon inflated for 3 min at 16 atm (C). [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

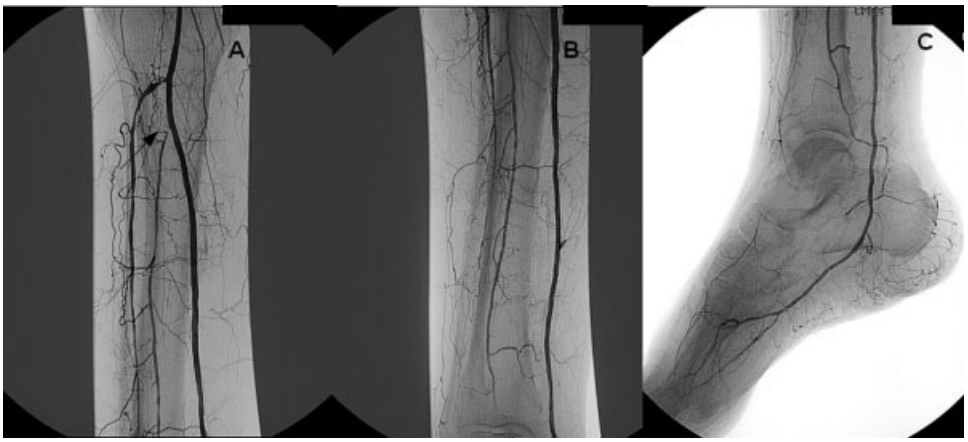

Fig. 6. (A, B, C) The final angiographic result with nonevidence of residual stenoses or flaps limiting the flow in the posterior tibial artery. The peroneal artery presents a residual stenosis at the ostium (A, arrow) not limiting the flow in this vessel.

vessel impairs guidewire advancement, or when distal disease makes retrograde percutaneous puncture impossible. In our experience, recanalization approach by means of collateral wiring loop is minimally invasive, as no additional percutaneous accesses are employed (at odds with the retrograde pedal or posterior tibial approaches), and the use of retrograde guidewire tracking minimizes the risk of ending up in a collateral branch while tackling antegradely the total occlusion. On the other hand, the mechanical properties of the guidewires and the balloons are stressed to their most extreme limits, as very challenging angles and extreme tortuosity must be conquered to complete retrograde below-the-knee recanalization using the ''transcollateral'' technique. Thus very low-profile balloons (e.g., the Amphirion over-the-wire balloon) and exchange-length guidewires are needed.

While this approach is novel for below-the-knee percutaneous interventions, some similarities can be found with a recent technique described in coronary interventions. Indeed, Rosenmann et al. reported in 2006 on three cases in which challenging chronic total coronary occlusions were successfully crossed by using a retrograde approach from collaterals coming from controlateral native vessels [6]. These authors provided also hypotheses for the fact that a retrograde wire could cross more easily an occluded vessel: (a) possible existence of channels with a more crossable stump at the distal end of the occlusion; (b) the potential difference in pathologic composition of the distal part of the occlusion with respect

to the proximal part, such as the presence of less fibrous and calcified tissue.

In our opinion, this procedure seems technically plausible and attractive, especially in patients with distal disease in whom the pedal artery access methods are not practical. Moreover, it looks technically easier than retrograde posterior tibial approach method. For sure, the ''transcollateral'' technique needs to be tested in additional series of patients, mainly with diabetes or renal insufficiency, where larger proportions of infrapopliteal occlusions are seen. Moreover, the success and complication rates of this new method need to be compared with other conventional and novel CTO methods, such as the aforementioned retrograde pedal artery access. To date our experience with ''transcollateral'' technique amounts to four cases: three successes and one failure (due to impossibility to wire retrogradely the occlusion), with no major complications (only one minor perforation of a collateral, completely managed noninvasively with prolonged balloon inflations). Thus, there is still a need for further clinical testing of this approach.

Another potential technique for challenging occlusions is the retrograde puncture of pedal-posterior tibial arteries. We previously described retrograde sheathless approaches in both tibial vessels to reduce the distal thrombosis and give more supports in crossing the occlusion of tibial arteries in a retrograde manner [2–4]. But the true limitations of the retrograde pedal access are: the impossibility to puncture (occluded and/or diseased pedal artery) and the risk of dissection and/or perforation and rupture of the pedal artery, a vessel suitable for b-pass distal graft. The ''transcollateral technique'' conversely remains a ''bail-out'' method limited to occlusions without an evident proximal stump (elective), or when the antegrade approach fails. The major limitation of ''transcollateral'' technique is the absence of collaterals suitable for wiring. Indeed, it is possible that, with the introduction of new CTO techniques and devices, the role of the currently described techinque may be limited to ''bail-out'' situations in which conventional CTO methods failed.

In conclusion, the ''transcollateral'' technique for percutaneous recanalization of below-the-knee arterial disease appears to be a promising new tool in the interventionist's armamentarium, either on a bail-out basis (i.e., in cases when antegrade revascularization fails), or electively (such as in the present clinical case) when traditional approaches are deemed unfeasible.

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