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*Technical Note*

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# Combined retrograde–antegrade arterial wiring: Peroneal artery can be a bridge to cross infrapopliteal Trans Atlantic Inter Society Consensus D lesions

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## Abstract

**Background:** Percutaneous transluminal angioplasty of complex infrapopliteal lesions might be a true and complex challenge. Success rates remain suboptimal when employing standard approaches. Thus, recanalization techniques for infrapopliteal disease remain a seat of continuous evolution.
**Aim of the study:** We report our results of Trans Atlantic Inter Society Consensus D infrapopliteal disease recanalization using combined antegrade-retrograde approach through peroneal artery branches.
**Patients and methods:** A total of 27 patients with infrapopliteal Trans Atlantic Inter Society Consensus D lesions underwent recanalization of at least one of the tibial arteries by combined retrograde–antegrade route using the peroneal artery normal anastomosis channels.
**Results:** Technical success was achieved in 22 patients who were followed for 6–24 months. Healing of ischemic ulcers or spontaneous separation of ischemic gangrenous patches in 13 patients. Minor amputation in nine patients. No major amputation in the follow-up period.
**Conclusion:** Although demanding, the technique can be reserved for selected cases with failed antegrade recanalization. This technique is valuable when a proximal occlusion is not crossable, when a dissection flap or a perforation in the proximal portion of a target vessel hinders guide-wire advancement. This technique may represent a feasible endovascular option to avoid second distal puncture exhausting the landing zone of a future distal bypass.



## Keywords

Retrograde antegrade revascularization, infrapoploiteal disease, peroneal artery


## Introduction

Endovascular therapy has been recognized as an established treatment option in the context of infrapopliteal disease. The aim of such intervention is to achieve ischemic rest pain relief, facilitate ulcer healing, prevent limb loss, minimize the extent of amputation, and permit wound healing after any type of amputation.[1]

Infrapopliteal lesions are classified into four types according to the Trans Atlantic Inter Society Consensus (TASC II) for the management of peripheral arterial disease, listed in Table 1. Generally, endovascular treatment is preferred in TASC A and TASC B lesions. Surgery is preferred rather than endovascular treatment in good-risk surgical TASC C patients. While in TASC D lesions, surgical bypass preferably using autogenous conduit is recommended. However, endovascular treatment still represents a valid therapeutic option on dealing with critical limb ischemia (CLI) due to TASC D infrapopliteal disease in the seat of poor distal runoff, absent suitable vein conduit, and in high-risk surgical patients.[2]

Approximately 20%–40% of patients with complex infrapopliteal occlusions cannot be treated using the conventional antegrade approach; 40% to 50% of these patients will suffer major amputation within six months after revascularization failure, and up to 20%

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**Table 1.** TASC II classification of morphologic stratification of infrapopliteal lesions.

| | |
|---|---|
| TASC type A: | Single stenosis <1 cm in the tibial or peroneal vessels |
| TASC type B: | Multiple focal stenoses of the tibial or peroneal vessel, each <1 cm in length One or two focal stenoses, each <1 cm long at the tibial trifurcation Short tibial or peroneal stenosis in conjunction with femoropopliteal disease |
| TASC type C: | Stenoses 1–4 cm in length Occlusions 1–2 cm in length of the tibial or peroneal vessels Extensive stenoses of the tibial trifurcation |
| TASC type D: | Tibial or peroneal occlusions >2 cm Diffusely diseased tibial or peroneal vessels |

TASC II: Trans Atlantic Inter Society Consensus.

**Table 2.** Demographics and clinical conditions of patients.

| Patients total number | 27 |
|---|---|
| Mean age (year) | 59 ± 13 |
| Gender | 19 Male (70.3%)<br>8 Female (29.6%) |
| Diabetes | 24 (88.8%) |
| Hypertension | 23 (85.1%) |
| Coronary artery disease | 17 (62.9%) |
| Dyslipidemia | 10 (37%) |
| Chronic renal failure | 5 (18.5%) |
| Rutherford class 4 | 8 (29.6%) |
| Rutherford class 5 | 12 (44.4%) |
| Rutherford class 6 | 7 (25.9%) |
| Isolated infrapopliteal disease | 18 (66.6%) |
| Combined with ipsilateral iliac disease | 1 (3.7%) |
| Combined with ipsilateral femoropopliteal disease | 8 (29.6%) |

will die.[3] Failure of antegrade recanalization of occluded tibial arteries is not uncommon situation, which makes even the most expert interventionist resort to unusual techniques in order to restore direct blood flow to the foot.[4,5]

The concept of retrograde recanalization technique was attempted in coronary interventions with a high success rate. It was assumed that the distal portion of an occluded vessel is less fibrotic or contains less calcified tissue and allows for easier passage of a guidewire through an occlusion. In other words, the guidewire can easily pass into the true lumen when advanced from the retrograde access artery.[6,7]

More recently, combined retrograde–antegrade approach is suggested as an option to recanalize tibial arteries. This technique aims to achieve arterial recanalization through collateral vessels using a single access site.[8,9] We hereby report the clinical results of combined retrograde–antegrade recanalization in challenging TASC D infrapopliteal lesions.

## Patients and methods

### *Patients*

This study was conducted mainly at the faculty of medicine, Kasr Al-Aini Hospital, Cairo University from June 2011 to December 2014. The study group included 27 patients (19 males and 8 females) out of 187 infrapopliteal disease patients that underwent trial of endovascular treatment for Rutherford ischemia class 4 (8 patients), class 5 (12 patients) and class 6 (7 patients). Mean age was 59 ± 13 years. The study group had TASC D infrapopliteal disease which was a part of significant multilevel disease in five patients in whom associated ipsilateral iliac disease was treated in one patient and ipsilateral femoropopliteal disease was treated in four patients. The underlying arterial disease was determined from patient history, clinical examination and confirmed by color doppler ultrasonography or CT angiography for proper planning prior to endovascular intervention.

The potential benefits and risks of the endovascular treatment were explained to each patient and written informed consent was obtained. Each patient was also informed for a possible second distal artery puncture from the tibial arteries at the ankle level if the attempt from the inguinal region failed. The procedure and the retrospective study were conducted in accordance with the local ethics committee rules.

All patients included in the study suffered from unsuccessful antegrade recanalization attempts and had angiographic evidence of patent proximal segment of the peroneal artery together with distal reconstitution of either the anterior tibial artery (ATA) or posterior tibial artery (PTA). Patients who had significant ipsilateral iliac or femoropopliteal artery occlusive disease were also treated during the same session. Patients' demographics, comorbidities and clinical conditions are summarized in Table 2.

### *Procedure*

The procedure was carried out in angiography suite under local infiltration anaesthesia. After field preparation, access site was decided according to the disease pattern where ipsilateral common femoral artery (CFA) puncture was done in 22 patients. A contralateral CFA


**Figure 1.** Angiography showing TASC D infrapopliteal disease. (a) Patent proximal portion of the popliteal artery. (b) Refilling of patent distal portions of anterior and posterior tibial arteries.

retrograde approach was needed in five patients who had concomitant iliac (one patient) or proximal superficial femoral artery (SFA) disease (four patients). A 5 F or 6 F, short or long vascular sheath was inserted into the selected access artery. Unfractionated heparin (5000 IU) was administered intra-arterially after placement of a vascular sheath. Diagnostic angiograms were obtained from the iliac, CFA or SFA and then selectively from the popliteal to the tibial arteries at the ankle level (Figure 1(a) and (b)).

Trials of antegrade recanalization of target vessels are first fulfilled whether intraluminal or subintimal. Intraluminal recanalization is attempted specially in calcified vessels using 0.018″ or 0.014″ hydrophilic guidewire supported with Berenstein catheter or low profile balloon. Subintimal technique is performed using 0.018″ guidewire and support catheter or catheter balloon (Figure 2(a) to (c)).

In all patients, recanalization of tibial or foot arteries were done via the natural vessel anastomoses with distal peroneal artery branches to accomplish a new direct blood flow line to the foot. Wiring of peroneal artery was done by 0.035″ hydrophilic Terumo wire supported with 3 mm balloon (Figure 3(a) to (c)). While looping into its branches back into either ATA or PTA is best done with V18 wire that is supported by 2.5 or 3 mm balloon. Recanalization was achieved in a point in one of the tibial arteries. Looping the wire back to the popliteal artery origin was tried, but unfortunately this was not successful in any patient because of limited pushability and torque of the wire/catheter to cross such heavy lesions.

Retrograde recanalization was completed either by reentry of the wire into the patent segment of tibial artery in 18/22 (81.8%) subjects while ''Rendezvous'' technique was adopted in 4/22 (18.1%) subjects when the retrograde wire meets the antegrade subintimal plane (Figure 4(a) and (b)). If there was vasospasm after balloon angioplasty, nitroglycerin (100 µg doses, repeated when necessary) was administered through the proximal sheath.

## Results

The procedure was performed in 27 cases. Technical success (ability to deliver the catheter balloon across the lesions and inflate it to nominal pressure) was achieved in 22/27 cases (81.4%), with adequate angiographic results (satisfactory direct blood flow to the foot). Failure to reenter the true lumen was the cause of technical failure in three patients while recurrent thrombosis due to spasm was the cause in other two patients. Successful re-PTA to the initially revascularized artery was performed in three patients (13.6%). The mean operative time was $109.31 \pm 20.19$ min (range 80–150 min).

A distal segment of ATA or PTA was found suitable for a retrograde percutaneous access in 10 patients.

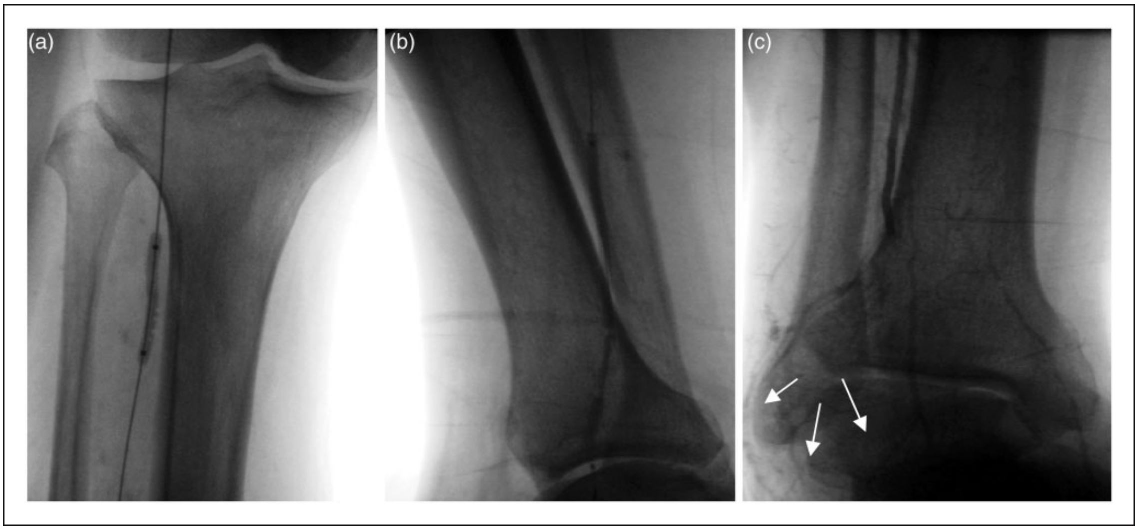


**Figure 2.** (a and b) Antegrade recanalization of the peroneal artery whether intraluminal or subintimal. Hydrophilic 0.035″ guide wire was used in most case supported with Berenstein catheter or low profile balloon. Intraluminal recanalization is attempted specially in calcified vessels using 0.018″ or 0.014″ hydrophilic guidewire. Subintimal technique is performed using 0.018″ guidewire and support catheter or catheter balloon. (c) Patent natural collateral channel connecting the peroneal and anterior tibial arteries (white arrows).

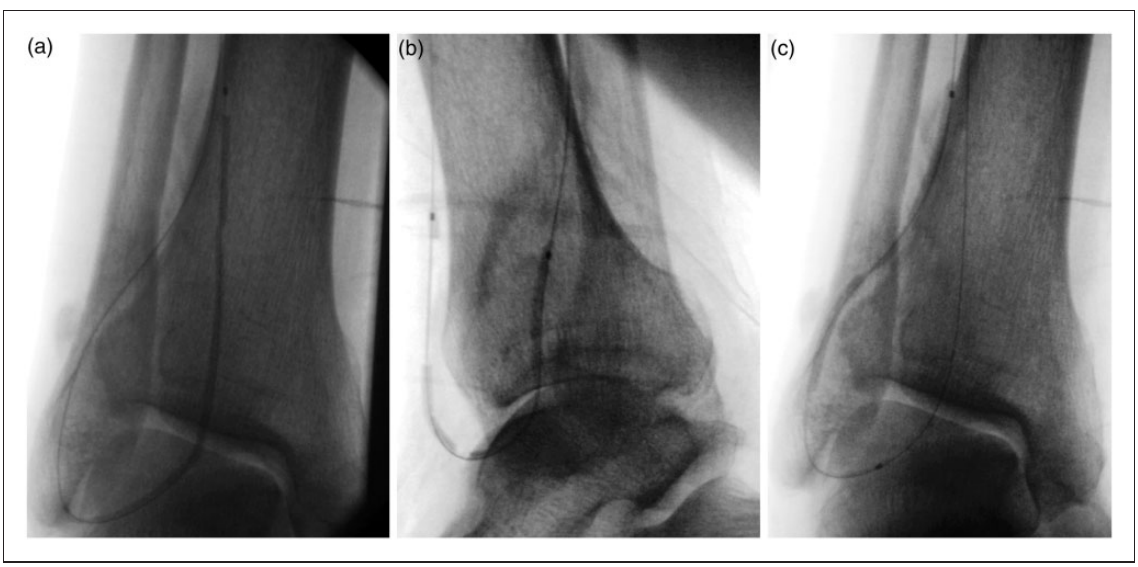


**Figure 3.** (a) Completion of peroneal artery PTA together with wiring of the ATA through natural anastomotic channel. (b and c) Looping back into ATA that was best done with V-18 wire supported by 2.5 or 3 mm balloon.

However, combined retrograde–antegrade recanalization was successful in six patients. In a total of five failed patients, retrograde percutaneous recanalization was adopted in three patients while one patient was a candidate for short distal bypass. One patient was kept on conservative treatment relying on improved perfusion due to angioplasty of associated femoropopliteal disease then underwent minor amputation.

In technically successful cases, the mean follow-up period was $11.81 \pm 5.56$ months (range 6–24 months). Follow-up was done both clinically and by measurement of pressure and velocity that was compared with pre-treatment values and maintained during the follow up. The mean value of ankle brachial index (ABI) was significantly increased from $0.43 \pm 0.13$ to $0.85 \pm 0.15$ after intervention ($P < 0.001$) in diabetic patients and from $0.44 \pm 0.11$ to $0.86 \pm 0.13$ after intervention ($P < 0.001$) in non-diabetic patients. Healing of ischemic ulcers or spontaneous separation of ischemic gangrenous patches in 13 patients. Minor amputation (toe or forefoot) in


**Figure 4.** (a and b) Retrograde recanalization was then completed by antegrade recanalization either by reentry of the wire into the patent segment of tibial artery or a "Rendezvous" technique is done when the retrograde wire meets the antegrade subintimal plane.

nine patients. No major amputation in the follow-up period.

## Discussion

Infrapopliteal arterial occlusive disease, with or without concomitant inflow disease, is a leading source of CLI especially in diabetic patients. The continuous advance in the field of vascular interventional radiology has facilitated infrapopliteal angioplasty through the development of low-profile balloon catheters, various small-caliber stents, steerable hydrophilic guide wires, road map facilities, vasodilators, and antiplatelet medications. This is why endovascular techniques has become an integral entity in the context of below the knee (BTK) arterial occlusive disease.[10,11]

Endovascular treatment of CLI in BTK arterial occlusive disease can be an exceedingly challenging and complex problem. The rapid and continuous evolution of various endovascular devices and techniques often allow the interventionist to treat increasingly complex and diffuse patterns of disease. The improvement in technical success rate and clinical outcomes, with resultant high rate of limb salvage and amputation-free survival are encouraging. These advantages widened the spectrum of eligible candidates to endovascular techniques to include TASC C and even TASC D infrapopliteal disease.[12]

In the context of BTK angioplasty, antegrade approach whether intraluminal or subintimal is associated with failure rate mounting to 20%, hence the importance to pursuit technical refinements.[13] Failure of antegrade approach is confronted when one of the following scenarios is reached, either inability to correctly identify the origin of an occluded tibial artery, rupture or loss of the antegrade vessel pathway, inability to reenter into the true distal patent lumen due to limited distal "landing" zone or vessel calcification or high risk to damage, continuing the antegrade subintimal dissection, the distal target vessel which could be the only landing zone of a distal bypass.[14,15]

When the antegrade approach fails, retrograde percutaneous accesses through the tibials, pedal or metatarsal punctures together with transcollateral access have been described as valid options for retrograde wiring. Although transcollateral wiring is appealing, its use was checked by the technical ease of distal puncture techniques. However, the distal portion of tibial vessels is sometimes not suitable candidates for the puncture. In such situations, a trans-collateral retrograde approach is one of the optional techniques for BTK recanalization.[16,17]

The peroneal artery often remains patent despite disease or occlusion of other infrapopliteal arteries. The peroneal artery communicates distally with the PTA via one to three transverse communicating branches and with the ATA via the anterior perforating branch. The natural anatomical features of the peroneal artery and pattern of its anastomois with tibial arteries characterize it as a bridge to access either of the tibial arteries in view of the angiosomal pattern of foot ischemic territory.[18–20]

In 22 successful patients included in this study, ATA was accessed in 13 (59%) cases, while the PTA was accessed in 9 (41%) patients. There was an attempt to stick to the angiosome concept in all patients; however, a direct flow to the angiosome feeding the tissue loss area was achieved in 14 (63.6%) patients compared with indirect revascularization in 8 (39.2%) patients. It was clearly evident in the follow up that foot tissue loss areas treated with angiosome-targeted infrapopliteal percutaneous transluminal angioplasty healed better.

Our results show the feasibility of the technique as an alternative to the conventional antegrade wiring. The value of the technique was especially evident not only when antegrade approach failed but also as a salvage procedure when a retrograde percutaneous access was complicated by dissection or acute occlusion allowing recovery of the complication by a accessing the tibial artery through a natural pathway. In addition to technical success, it proved satisfactory clinical outcome in view of the radiological follow up, amputation rate and patency.

In spite of the feasibility of the technique, it is important to emphasize that the procedure has its failure rate. In our study, the technique failed to recanalize five (18.5%) patients. This failure was met in diabetic patients in whom the long nature of the disease together with calcific vessels and overall poor outflow status of foot arteries were incriminated. However, it still comprises an important option in the armamentarium of infrapopliteal disease revascularization especially in poor surgical risk patients.

## Conclusion

Although technically demanding, the technique can be reserved for selected cases with failed antegrade recanalization. This technique may be of value specifically when a proximal occlusion is not crossable, when a dissection flap or a perforation in the proximal portion of a target vessel hinders guidewire advancement. This technique may represent a feasible endovascular option to avoid second distal puncture exhausting the landing zone of a future distal bypass.

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