Retrograde transtibial technique as an alternative to the antegrade approach for the treatment of chronic lower-limb ischemia

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Background
Patients with complete occlusive lesions of the infrainguinal, and more frequently infragenicular, arteries have comorbid diseases that favor the endovascular option for treatment. In those patients the retrograde transtibial approach is suggested when the antegrade approach fails. This study aimed to describe the feasibility and complications of this approach.
Patients and methods
The retrograde transtibial approach was used, after a failed trial with the antegrade approach, in 29 patients suffering from severe chronic lower-limb ischemia. Success in accessing the tibial arteries, crossing the lesion, effectively dilating the occluded lesions, patency up to 6 months, and complication rate were measured.
Results
In all patients one of the tibial arteries was successfully accessed and the lesion was crossed. Postdilatation contrast study confirmed successful dilatation, which was maintained for 6 months, with no significant complications.
Conclusion
The retrograde transtibial approach is a feasible and safe alternative in treating infrainguinal arterial lesions when the antegrade approach fails or cannot be used.

Keywords:
endovascular, retrograde, transtibial

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Introduction

Peripheral vascular disease (PVD) is a widespread problem that has the potential to cause loss of limb or even loss of life [1]. In western countries, the prevalence of PVD in the general population is 12–14%, affecting up to 20% of those over 70 [2]. The incidence of symptomatic PVD increases with age, from about 0.3% per year in men aged 40–55 years to about 1% per year in men aged over 75 years [3]. In the 21st century it became a clear problem in low-income and middle-income countries, which needs to be addressed [4].

PVD manifests as insufficient tissue perfusion initiated by existing atherosclerosis. Risk factors such as diabetes, hypertension, smoking, hyperlipidemia, and lack of exercise contribute to the progress of the disease [2,4]. Patients with PVD commonly suffer from coronary artery disease and visceral and cerebrovascular insufficiency. It is estimated that less than one-third of them will need surgical or radiologic intervention for their limbs. However, data show that patients with symptomatic PVD have at least a 30% risk for death from myocardial infarction or cerebrovascular disease within 5 years. Therefore, PVD is an independent risk factor for cardiovascular death [5].

Patients suffering from chronic lower-limb ischemia due to infrainguinal obstructions are usually high-risk surgical patients because of their many comorbidities [6]. Open vascular revascularization is not suitable for many of them. Fortunately, percutaneous angioplasty offered a suitable treatment option for this group of patients [7]. Furthermore, for patients with tibial occlusive disease, endovascular intervention has became the first option of treatment for these challenging lesions [8].

There are multiple choices for arterial access in angioplasty. The common femoral artery is the most commonly used site, through ipsilateral or contralateral cross-over. If the common femoral artery access is not suitable, alternatively, a retrograde ipsilateral approach can be used through the distal superficial femoral artery (SFA), the popliteal, the tibial, or the dorsalis pedis artery [9]. Another indication for the retrograde approach is the inability to return to the true lumen after subintimal dissection. The suggested re-entry

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devices are expensive and their use is sophisticated. Therefore, they can be replaced by different retrograde approaches [9].

Popliteal artery access has grown in popularity as an alternative to cross SFA occlusions from a retrograde approach [10]. The disadvantage of the need to change the position of the patient is overcome now by performing the procedure in the supine position [11]. However, it is still unsuitable if tibial lesions coexist.

On the other hand, retrograde transtibial access seems to be a potentially effective alternative for endovascular treatment of infrainguinal arterial lesions in patients not amenable to antegrade procedures [12–15].

Aim of the study

This study was conducted to explore the feasibility and complications of this approach in treating infrainguinal lesions when the antegrade approach cannot be used or has failed.

Patients and methods

This is a prospective study conducted over a period of 15 months. Patients with chronic lower-limb ischemia, Rutherford's category 3–6, admitted for intervention at Suez Canal University Hospital, were considered the target population. After obtaining approval from the local ethics committee and consent from the patient before the operation, we started with the antegrade approach, ipsilateral or contralateral. Those patients with infrainguinal lesions fulfilling the following criteria were included in the study.

Inclusion criteria

(1) Antegrade recanalization failure due to the following:
   (a) Inability to recognize the mouth of the occluded artery (flush occlusion).
   (b) Failure to cross the occlusion either through the true lumen or by creating a subintimal plane.
   (c) Failure of re-entry into the true lumen after subintimal dissection.
(2) Has distal run-off (patent distal part of at least one tibial vessel).

Patients who fell under following criteria were excluded from the study.

Exclusion criteria

(1) Refused to be included in the study.
(2) Infection at the site of puncture.
(3) Single tibial vessel run-off, unless the patient had critical limb ischemia.

Information regarding the demographic data, risk factors, associated chronic illnesses, presenting symptoms, clinical signs and examination, lesion Trans-Atlantic Inter-Society Consensus (TASC) classification [16], and results of laboratory tests were obtained for all legible patients.

Technique of the transtibial approach

(1) First, it was ensured that the antegrade femoral approach, either ipsilateral or contralateral, conducted in the operation room under complete aseptic conditions, had failed.
(2) The vertebral catheter used during the antegrade attempt was placed as far as possible, close to the proximal end of the occlusion, to allow contrast injection to guide the tibial puncture.
(3) The tibial arteries were visualized by the contrast injected from above through the vertebral catheter. We looked for a disease-free segment of the artery just above the ankle joint. If the three vessels were suitable for puncturing, and because of the stability of the vessel during puncture, the anterior tibial artery (ATA) was preferred, followed by the peroneal and lastly the posterior tibial artery (PTA).
(4) After skin preparation, the foot was positioned in plantar flexion when accessing the ATA. It was inverted when accessing the distal peroneal artery and was everted and dorsi-flexed when accessing the PTA. The needle was inserted while injecting the contrast from above by the assistant.
(5) After successful vessel puncture, a 0.18′ guidewire was inserted retrograde through the vessel and then through the occlusion and back into the lumen above the lesion. The guidewire was negotiated and entered into the tip of the vertebral, and then through and out of it at the femoral access site. Thereafter, the vertebra was pushed down over the wire beyond the lesion as far as the distal entry of the wire to the vessel. The wire was removed and reinserted with its soft tip through the vertebral catheter from above and advanced distally in the vessel beyond the retrograde puncture site.
(6) Dilatation was performed using an appropriately sized balloon advanced from the femoral site, compressing and sealing the retrograde puncture. Repeated dilatation was performed for any residual stenosis greater than 30% or for flow limiting dissection, for which a bare metal stent was deployed.

Follow-up

The improvements in symptoms, pulses, and ankle brachial pressure index (ABPI) [17] were recorded the next day before discharge, and thereafter at 1 week, 1 month, after 3 months, and after 6 months. An increase in ABPI more than 0.15 mmHg before discharge was considered a success. Arterial duplex was done on a regular basis for all patients at 1, 3, and 6 months. CTA was performed when there was possibility of restenosis or occlusion. Complications, if present, were recorded.

Study endpoint

(1) Failure to access one of the tibial arteries.
(2) Failure to cross the lesion from below.
(3) Restenosis more than 30%, or flow limiting dissection that cannot be corrected.
(4) Arterial thrombosis before discharge or significant restenosis (>50%) at any time during 6 months' follow-up.
(5) Six-month follow-up of the successful cases.

Results

From January 2014 to March 2015, a total of 210 patients underwent endovascular interventions. Out of those, 29 (14%) patients who fulfilled the inclusion and exclusion criteria underwent retrograde transtibial endovascular angioplasty for infrainguinal arterial lesions after failed antegrade access.

The indication for retrograde approach in those patients was inability to pass through the true arterial lumen or subintimally [in (34.5%) 10 patients] and failure of re-entry [in 19 (65.5%) patients].

Those 29 patients consisted of 21 (72.4%) men and eight (27.6%) women. Their ages ranged between 55 and 75 years, with a mean age of 68 years. The risk factors and associated diseases are shown in Table 1.

Regarding the presenting symptoms, five (17.2%) patients presented with severe limiting claudication and 24 (82.8%) patients with ischemic rest pain. In eight (33.3%) out of 24 patients it was associated with gangrene in the toes or unhealed ulcer.

Regarding the distribution of the lesions according to TASC radiological classification, 14 (48.3%) patients had TASC type D1 and D2, eight (27.6%) patients had TASC type D1 and C2, four (13.8%) patients had TASC type C1 and D2, and only three (10.3%) patients had TASC type C1 and C2 (Fig. 1).

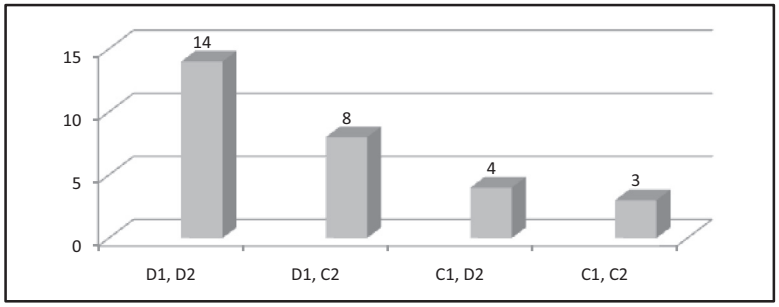
After failure of the antegrade approach, the procedure was completed by accessing the PTA in 15 (51.7%) patients, the ATA in nine (31.0%) patients, and through the peroneal artery in five (17.2%) patients. In all of the 29 patients, one of the tibial arteries was punctured, wired, and lesions were crossed successfully.

Regarding the distribution of the studied population according to the performed technique, balloon angioplasty was performed alone in 24 (82.8%) patients and balloon+stenting in five patients (17.2%).

Table 1 Demographic data and risk factors of the studied population

Variables	*n* (%)
Sex	
Male	21 (72.4)
Female	8 (27.6)
Diabetes	24 (82.8)
Hypertension	22 (75.9)
Ischemic heart disease	19 (65.5)
Smoking	20 (68.9)
Hyperlipidemia	18 (62.1)

Figure 1



Number of patients according to the TASC classification. C1 and D1, femoropopliteal lesions; C2 and D2, infrapopliteal lesions; TASC, Trans-Atlantic Inter-Society Consensus.

Figures 2 and 3 show examples of ATA and PTA access, ballooning, and postangioplasty angiography for the treatment of infragenicular lesions.

The mean ABPI improved from 0.41 before intervention to 0.74 on the first day after intervention. This increased to 0.79 in the first week, to 0.81 in the first month, to 0.83 in the third month, and to 0.85 at 6 months after intervention. This change in mean ABPI was statistically significant (Fig. 4).

By the end of the follow-up period, none of the patients had hematoma, infection, thrombosis, or aneurysm. Few patients had superficial bruises and ecchymosis, which disappeared a few days after the procedure.

Discussion

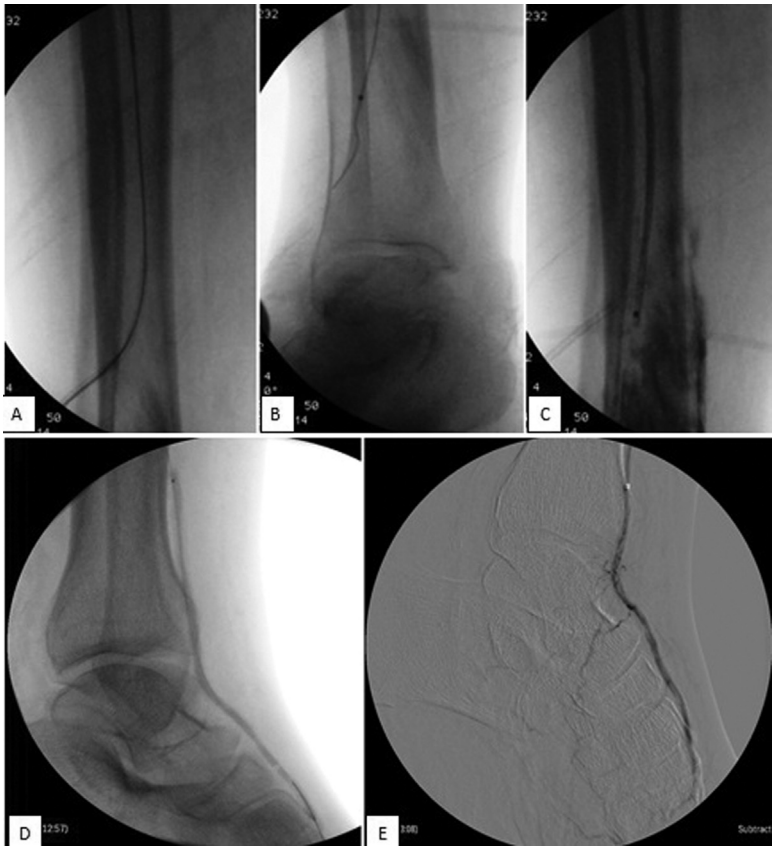
In recent times, endovascular intervention has been considered the first option of treatment for PVD. Efforts have been made to increase the success rate of this modality of treatment by developing new tools and techniques that enable the surgeon to overcome the challenges faced during the procedure. Of these techniques, retrograde tibial artery access is a promising alternative for patients in whom conventional antegrade endovascular techniques failed to achieve recanalization of the lower SFA, popliteal, and/or tibial vessels.

Over a period of 14 months, only 14% of the endovascular interventions performed for PVD in our hospital were through the retrograde transtibial approach. This indicates that the antegrade approach, when feasible, is the preferred one. This was reflected in the sample size, as observed in other studies as well. Botti *et al.* [18] included only six patients and Roger *et al.* [19] included 13 patients. This may suggest a general consensus that revascularization by puncturing the run-off vessel is not justified as the first option, as its failure may jeopardize the antegrade option. However, surgeons skilled in the technique should be available when needed.

The risk factors in the studied group of patients were as expected for the indication for this intervention, as observed in previous studies [9,20].

Most of the patients presented with a severe form of ischemia. In our study 83% of the patients presented with rest pain. This agrees with the observation

Figure 2



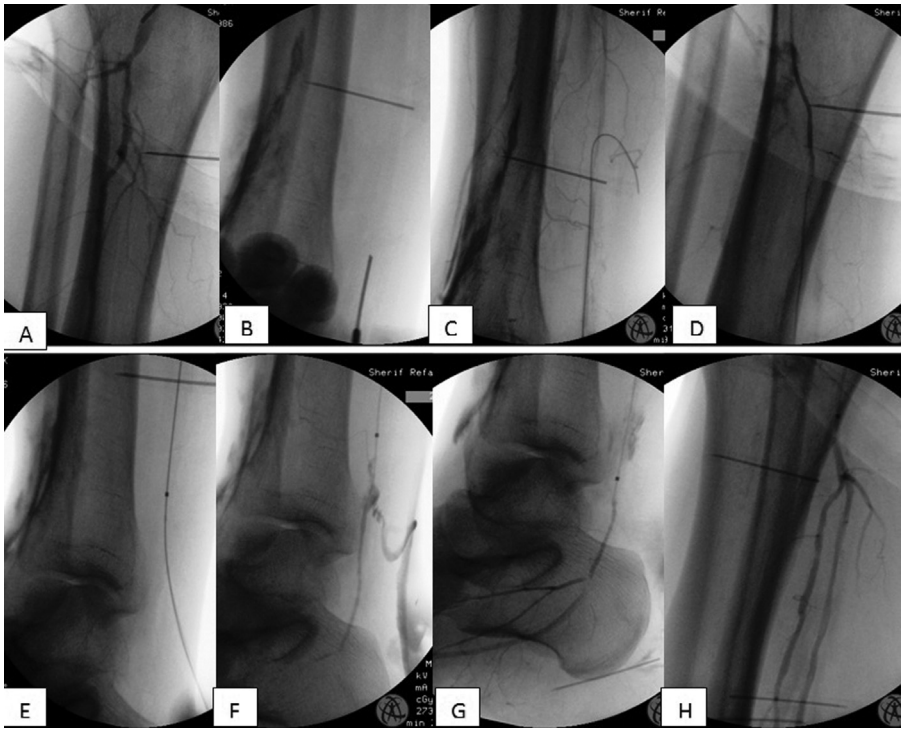
Access through the anterior tibial artery: (a) retrograde wiring; (b) balloon just above the access site; (c) just beyond the access site; (d) ballooning; and (e) postangioplasty angiography.

made in previous studies. All patients included in the study by Botti *et al.* [18] presented with critical limb ischemia. Most of the patients (62%) in the study by Roger *et al.* [19] had critical limb ischemia. The same was found by Montero-Baker *et al.* [9] as 88% of their patients presented with critical limb ischemia . Again, all patients studied by Walker [20] had critical limb ischemia. This severe form of ischemia may explain the recognized severe calcification and the failure to cross the lesion from above, but it is not clear why it is easy to cross the same lesion from below. The shape of the occlusion resulting from the calcium precipitation on the vessel wall, affected by the direction of its build-up overtime, may explain this phenomenon.

Regarding the access site, the PTA was the suitable artery for access in most of the patients (47.8%). This agrees with the observation made in previous studies. It was the access artery in 67% of patients in the study of Botti *et al.* [18] and in 85% in the study of Roger *et al.* [19]. This observation may suggest that the distal part of the PTA is the last segment to be affected by atherosclerosis in chronic ischemia.

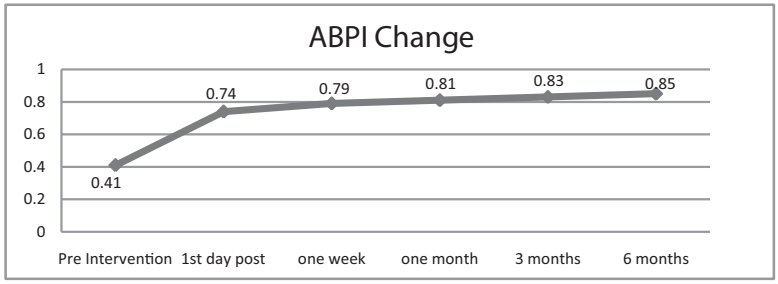
Tibial puncture was successful in all patients and the targeted lesion was successfully treated. This 100% success rate was also recorded by Botti *et al.* [18] and by Hua *et al.* [21]. Such high success rates were also recorded by others such as Montero-Baker and *et al.* [9] (87%) and Roger *et al.* [19] (85%). This high

Figure 3



Access through the posterior tibial artery: (a) vertebral at the popliteal artery; (b) needle in position; (c) wire advanced into the artery; (d) wire going into the vertebra; (e) balloon down near the entry site; (f) contrast through the balloon showing the entry site; (g) balloon below the entry site; (h) postdilatation angiography.

Figure 4



The change in mean ABPI (*N*=29). ABPI, ankle brachial pressure index.

success rate confirms that the transtibial approach is feasible and successful when indicated. This satisfactory result improved the ABPI and maintained it for 6 months.

In our study, minor complications were reported, in the form of nonsignificant subcutaneous hematoma. These complications are also expected during the antegrade transfemoral approach and were not specific to the retrograde approach. No significant complications were recorded for 6 months. We do not expect the incidence of long-term complications to differ depending on whether the lesion is accessed from above or from below. This low rate of complications confirmed the early suggestions regarding the safety of the procedure [9,19–21].

Conclusion

The transtibial approach is feasible, safe, and successful in treating infrainguinal arterial lesions when indicated. This approach should lend support to continue using the endovascular procedure when the antegrade approach fails.

This technique allowed completion of the procedure without the need of a re-entry device, an alternative that would add significant cost to the procedure.

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Conflicts of interest

There are no conflicts of interest.

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