Retrograde transpopliteal access in the supine patient for recanalization of the superficial femoral artery after failed antegrade angioplasty

Ashraf Eweda[a], Wael El Shemy[b], Mohamed Sad[a], Mohamed Hamza[a], Aser Gouda[c], Ahmad Tawfik[b]

[a]Vascular and Endovascular Unites in Al azhar Faculty of medicine, Cairo, [b]Zagazig Faculty of Medicine, Zagazig, [c]Sohag Faculty of Medicine, Sohag, Egypt

Correspondence to Wael El Shemy, MD, Zagazig Faculty of Medicine, Zagazig University, Zagazig, Egypt
Tel: 0552312621; fax: 0552362621
E-mail: wael.elshimy@yahoo.com

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Background
The prevalence of peripheral arterial disease is increasing worldwide due to the increase in life expectancy, obesity, and diabetes. Symptomatic atherosclerosis of the lower extremity arteries commonly involves the superficial femoral artery (SFA) and is characterized by long, diffuse lesions and long total occlusions.

Patients and methods
All patients underwent percutaneous recanalization from a retrograde popliteal access after failure to pass through the antegrade access either by the ipsilateral or by the contralateral femoral approach. All patients were symptomatic with ipsilateral disabling intermittent claudication.

Results
Technical success, defined as puncture of the popliteal artery and recanalization of the SFA, was achieved in all cases. The mean ankle–brachial index increased from 0.5 ± 0.2 preoperatively to 0.7 ± 0.1, with improvement in the walking distance. Primary patency was 80.7% at 6 months and 76.9% at 1 year.

Conclusion
Percutaneous recanalization of femoropopliteal TASC C and D lesions can be increased by the transpopliteal approach. The retrograde popliteal approach with the patient in the supine position can be considered a 'first-choice' method for safe and effective SFA recanalization, especially in occlusions located at the distal and the mid portion SFA and that failed to pass through the femoral antegrade approach. It is an inexpensive and easy-to-learn technique.

Keywords:
angioplasty, recanalization, retrograde, transpopliteal

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Introduction

The prevalence of peripheral arterial disease is increasing worldwide due to the increase in life expectancy, obesity, and diabetes [1]. Symptomatic atherosclerosis of the lower extremity arteries commonly involves the superficial femoral artery (SFA) and is characterized by long, diffuse lesions and long total occlusions [1]. Endovascular therapy has seen major advances in the last decade with the introduction of several new techniques and devices [2]. SFA occlusions are generally managed by an antegrade ipsilateral or retrograde contralateral femoral approach ending in intraluminal or subintimal recanalization of the vessel lumen [3]. In case of failure, a retrograde popliteal access is considered as a valid alternative [4]. This technique, first described years ago by Tonnesen *et al.* [5], has diminished in popularity owing to complications, such as dissections, vessel ruptures, arteriovenous fistulas, pseudoaneurysm, and hematomas, which may all develop at the puncture site [6]. Since Trigaux *et al.* [7] described the relationship between the popliteal artery and vein and the safest technique to puncture the popliteal artery, several guidance methods for popliteal artery puncture have been reported, notably, ultrasound guidance (B-mode or color Doppler or a Doppler-equipped needle that identifies the arterial and the venous flow) [8] and contrast injection under fluoroscopy that creates a roadmap to guide the needle as it is advanced in the popliteal artery. A retrograde approach to chronic total occlusion (CTO) of the SFA through the ipsilateral popliteal artery has been used occasionally if an antegrade approach is not feasible or has failed. The rationale for this increased success rate is that the distal occlusion stump in this vessel, as in others, is usually tapered, thereby increasing the likelihood of intraluminal seating of guidewires. However, the retrograde popliteal approach to SFA occlusions is a relatively new technique and there have been few reports concerning complications with this approach [9].

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Indications for popliteal access (PA) include:

(a) An absent femoral pulse secondary to an iliac or common femoral occlusion, (b) severe calcification,
(c) Combined iliac and femoral lesions,
(d) Occlusion or a high take-off of the origin of the SFA, and
(e) Severe obesity.

PA can also be used to avoid scar tissue and when femoral angioplasty has failed [10]. Traditionally, popliteal artery access is obtained with the patient in the prone or the lateral decubitus position [11]. While retrograde popliteal access offers several advantages that facilitate SFA recanalization [12], the major drawback of this approach is the need for the patient to change position from supine to prone and then back to supine, which produces anxiety and discomfort. Moreover, once the patient is changed to a prone or a decubitus position, the remaining procedures must be performed through the popliteal access [13]. These maneuvers add to the patient's anxiety, make the situation uncomfortable, often prolong the procedure, and complicate the operator's job owing to the difficulty in handling the femoral sheath on which the patient is lying when prone. In addition, this approach is not feasible in patients who are obese, have impaired respiratory function, or have conditions that may interfere with positioning them prone or in the lateral decubitus [14]. To avoid this time-consuming and uncomfortable repositioning, a technique has been developed to access the popliteal artery with the patient in the supine position. With the patient supine, a medial retrograde popliteal access at the infracondylar plane was adopted, without turning the patient. Puncture of the distal PA was guided fluoroscopically and a guidewire was inserted into the true lumen, after which retrograde recanalization proceeded in accordance with the standard protocol [15].

The objective of this article was to report the use of a retrograde popliteal approach performed in a supine patient after failed antegrade angioplasty for CTO in the SFA and to demonstrate that supine retrograde popliteal artery access is a feasible, safe, and effective means to increase the success rate of percutaneous transluminal angioplasty for SFA occlusions after a failed antegrade attempt by means of ipsilateral or contralateral femoral access.

Patients and methods

From November 2012 to November 2014, 26 patients (16 men; mean age 68 ± 6 years) with chronic SFA occlusion (mean length 97.4 ± 3.76 mm) underwent percutaneous recanalization from a retrograde popliteal access. All patients were symptomatic with ipsilateral disabling intermittent claudication (Rutherford grade 3). Risk factors included smoking (n = 18, 75%), hypertension (n = 11, 45%), diabetes (n = 7, 29%), hypercholesterolemia (n = 15, 62%), and coronary heart disease (n = 4, 16%). Each patient underwent a preoperative color Doppler ultrasound scan, assessment of the ankle–brachial index, and multidetector computed tomographic angiography to obtain a complete anatomical overview of the occluded segment and the morphology of the abdominal aorta and peripheral arteries before treatment.

Written informed consent was obtained before each procedure.

The technique

All procedures were performed in the angiosuite under sterile conditions, with the patient in the supine position under local anesthesia (5 ml of 1% lignocaine) with or without intravenous sedation (diazepam 2–10 mg). All surfaces of the patient's affected leg was prepared with betadine wash: thigh to toes, in a thorough surgical manner. The leg was then exteriorized on the table through a hole in the drape. The common femoral artery was punctured with an antegrade (n = 12, 46%) or a retrograde contralateral (n = 14, 53.8%) approach. A 6-Fr, 25-cm-long introducer sheath was used for the antegrade access. Heparin (5000 U) was injected intravenously.

In every case, an initial attempt was made to recanalize the obstructed SFA from the femoral access using a 0.035-inch, 180-cm angle-tipped standard hydrophilic guidewire (Terumo) in combination with a 4-Fr straight catheter. Endoluminal recanalization proved impossible in all these cases owing to the morphological characteristics of the obstructions, and so a retrograde popliteal access was obtained. With the patient still in the supine position, the knee was flexed gently and rotated medially to achieve a good approach to the popliteal artery. The most suitable puncture point was where the popliteal artery was visualized without superimposition of the vein, which is usually proximal and medial to the knee joint and caudal to the semimembranosus muscle. Under fluoroscopic guidance, contrast was injected from the femoral approach to obtain a roadmap to visualize the popliteal artery. The C-arm was brought into a contralateral oblique (30–45 u) position (for the right SFA left oblique and vice versa) to facilitate fluoroscopically guided puncture with a 7-, 9-, or 15-cm-long, 21-G needle chosen to best suit the circumference of the thigh. The needle was used in

a coaxial technique to guarantee stable penetration through the muscle. During needle introduction, the C-arm can be brought into the ipsilateral position, 90 u to the previous projection, to aid in the assessment of the angle of the needle as it approached the artery (optimally,70 u) and to estimate the distance of the needle tip from its target. When the needle tip was visualized inside the popliteal artery lumen, a 0.018- or 0.035-inch, 180-cm angle-tipped standard hydrophilic guidewire (Terumo) was advanced into the distal patent portion of the SFA. The guidewire was inserted through the needle followed by a 4- or 6-Fr, 10-cm sheath. Once retrograde passage of the occlusion was successful (sometimes requiring a 'double-balloon' technique to disrupt the dissection membrane with balloons delivered from access sites), balloon angioplasty and/or stenting could be performed from either directions. A completion angiogram was then performed and the balloon dilatation was repeated for any residual stenosis greater than 30%. Catheters and guidewires were removed and hemostasis was achieved by hand.

Follow-up

All patients received low-molecular-weight heparin (40 mg × 2 days) in association with clopidogrel (75 mg/day) for 4 weeks followed by aspirin (100 mg/day) indefinitely. Clinical examination and duplex ultrasound were performed the day after the procedure and then at 1, 6, and 12 months. Computerized tomographic angiogram (CTA) was preserved for the presence of abnormalities or recurrent symptoms.

Results

Technical success, defined as puncture of the popliteal artery and recanalization of the SFA, was achieved in all cases. The procedure was well tolerated by everyone without any remarkable pain. Retrograde recanalization involved the insertion of a 6-Fr sheath in 11 cases and a 4-Fr sheath in 15 cases. The 'double-balloon' technique was necessary to achieve guidewire passage in 18 cases. In one case, the guidewire from the popliteal approach passed the obstructed segment through the subintimal space and re-entered the SFA lumen proximally. Stenting of the SFA was performed in 10 cases, whereas only balloon dilatation was performed in 16 cases.

The mean time of hospitalization was 2 ± 1 days (similar to patients treated with the transfemoral access only in our experience). Perioperative complications included two distal pseudoaneurysms and one small arteriovenous fistula at the distal puncture site. The mean ankle–brachial index increased from 0.5 ± 0.2 preoperatively to 0.7 ± 0.1, with improvement in the walking distance.

After a mean follow-up of 12.5 ± 4.8 months, 20 (76.9%) SFA arteries were patent. Restenosis occurred in the remaining six (23%) SFAs, but no stent fracture was observed. Three of the restenoses were redilated; the dilated balloon was kept in place for about 2 min. The other three cases were managed conservatively. Primary patency was 80.7% at 6 months and 76.9% at 1 year (Tables 1–6).

Discussion

Retrograde subintimal tracking through the popliteal approach, which utilizes the anatomical characteristics of the femoropopliteal artery, delivers an endovascular solution for unsuccessful antegrade crossing of an occlusive lesion [16]. However, the need for repositioning the patient during the procedure [17] and the potential risk of access site complications appear

Table 1 Age and sex distribution of the studied group

Age	68.6 ± 6
Sex [*n* (%)]	
Male	16 (61.5)
Female	10 (38.5)

Table 2 Risk factors

Smoking	18	75.0
HTN	11	45.0
DM	7	29.0
Hypercholesterolemia	15	62.0
CHD	4	16%
fx1		
fx2		
fx3		

DM, diabetes mellitus; CHD, coronary heart disease; HTN, hypertension.

Table 3 ABI

Test	Pre	Post	Paired *t*-test	*P*
ABI	0.5 ± 0.2	0.7 ± 0.1	7.42	0.00
fx4				

ABI, ankle–brachial index.

Table 4 Follow-up

Patent	20	76.9%
Restenosis	6	23.1%
P	0.00	

Table 5 Primary patency

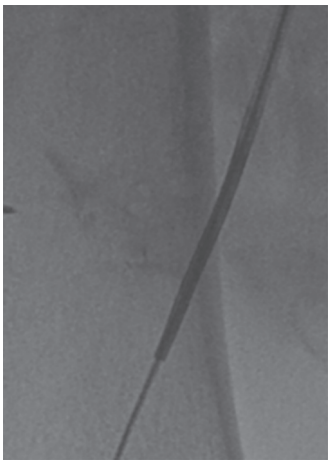
6 months	21	80.7%
1 year	20	76.9%
P	0.76	

to have impeded wider acceptance of the retrograde approach. The proximity of the artery and the vein at the popliteal fossa can carry the potential risk of puncture site complications, including arteriovenous fistula or gross hematoma after the removal of the popliteal sheath [14]. Moreover, once the patient is changed to a prone or a decubitus position, the remaining procedures must be performed through the popliteal access. More recently, this technique was modified to accommodate an entirely supine posture by lifting the heel or flexing and rotating the knee medially [4]. However, as shown in our cases, the patient remains supine during the entire antegrade–retrograde SFA intervention. The technique we used here enables access to the distal SFA and keeps the patient in a supine position, which has a number of advantages. Most importantly, it allows simultaneous manipulation of guidewires and balloon catheters from above and below. The SAFARI technique, which uses both antegrade and retrograde routes simultaneously, is highly successful [12]. There are several limitations in this technique that should be considered. First, a couple of failed attempts of popliteal artery puncture could worsen limb ischemia, with devastating clinical results. Therefore, this technique cannot be a first-line in the endovascular treatment of CTOs in the SFA. Second, patients with extensive occlusion or severe stenosis in the popliteal artery would not be suitable for this approach owing to the high potential of puncture failure and aggravating limb ischemia after sheath placement [18]. Puncture of the distal SFA was performed using fluoroscopy and contrast was injected through the antegrade sheath. This technique was found to be quick and simple to perform; however, ultrasound-guided puncture would be a reasonable alternative. Ultrasound may also minimize the amount of contrast required during the procedure and reduce radiation exposure to the hands of the interventionist and prevent transition of the needle through the accompanying superficial femoral vein, with the risk of arteriovenous fistula [13]. It has been postulated that recanalization may be more successful given the less severely fibrotic/calcified thrombus when approached from the distal end [19]. PA can be performed safely with a high rate of technical success [20]. Zaitoun and colleagues reported an 81% primary angiographic success rate for the popliteal approach, although there was no long-term follow-up. In this study, primary patency was assessed clinically, which is ultimately the most important factor in determining the success of any intervention. Further, it is accepted that objective radiological measurements of patency would have provided further information. Concerns have been highlighted with regard to the incidence of local complications after PA [21]. The formation of arteriovenous fistula has a reported incidence as high as14%; puncture site arterial dissection or thrombosis and peroneal nerve palsy secondary to hematoma have also been described [22]. In our study, the incidence of local puncture site complications was 11.5% (Figs 1, 2).

Conclusion

Percutaneous recanalization of femoropopliteal TASC C and D lesions can be increased by the transpopliteal approach. The retrograde popliteal approach with the patient in the supine position can be considered as a 'first-choice' method for safe and effective SFA

Figure 1



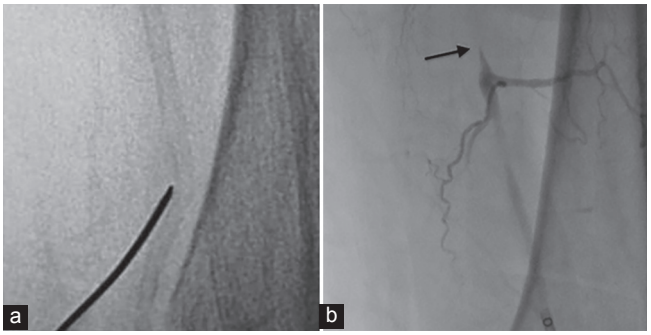
Balloon angioplasty p1.

Table 6 Risk factors for restenosis

Age (mean ± SD)	Restenosis	Patent	*P*	OR (95% CI)
	68.81 ± 4.2	68.45 ± 7.2	0.81	
Sex [*n* (%)]				
Male	4 (66.7)	12 (60.0)	0.76	
Female	2 (33.3)	8 (40.0)		
Smoking	6 (100.0)	12 (60.0)	0.001	10.8 2.3–33.5
HTN	2 (33.3)	9 (45.0)	0.17	
DM	2 (33.3)	5 (25.0)	0.29	
Hypercholesterolemia	5 (83.3)	10 (50.0)	0.004	10.0 1.9–17.5
CHD	1 (17.7)	3 (15.0)	0.63	

DM, diabetes mellitus; CHD, coronary heart disease; CI, confidence interval; HTN, hypertension; OR, odds ratio.

Figure 2



(a, b)The retrograde transpopliteal approach.

recanalization, especially in occlusions located at the distal and the mid portion SFA and that failed to pass through the femoral antegrade approach. It is an inexpensive and easy-to-learn technique.

Acknowledgements

Conflicts of interest

None declared.

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