Retrograde popliteal and pedal access in management of superficial femoral artery occlusion after failed antegrade approach: a comparative study

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Aim
To evaluate feasibility, efficacy, and safety of popliteal access compared to tibial retrograde approach for management of chronic total occlusion of superficial femoral artery after failed antegrade recanalization.
Patients and methods
The study was carried out from January 2016 to April 2019 at Sohag University Hospitals on 30 patients experiencing chronic total occlusion of superficial femoral artery and underwent retrograde transpopliteal or transpedal approach after failed antegrade intervention. Technical success and procedure-related complications were evaluated and compared among patient groups.
Results
Popliteal access was performed in 14 patients, whereas pedal puncture was accessed in 16 patients. Mean age was 57 (50–64) and 63 (52–65) years in popliteal and pedal access groups, respectively. There were no significant differences in patient baseline characteristics. Arterial puncture was successful in pedal than popliteal access (94.4 vs. 92.9%, P=0.96). Technical success was higher in patients with pedal access than those with popliteal puncture (87.5 vs. 78.6%, P=0.19). Operative time was shorter in pedal access than popliteal access (90±35, 120±28 min, P=0.04). Time to achieve hemostasis was 12±4.6 and 5 ±1.7 min in popliteal and pedal access, respectively (P=0.022). Access-site hematoma was higher in popliteal access group than pedal access group (28.6 vs. 6.3%, respectively, P=0.042). Spasm of pedal vessels occurred in three (18.8%) patients, acute thrombosis in two (6.7%) patients, access-site occlusion in one (6.3%) patient, and wire perforation in two (12.5%) patients.
Conclusion
When antegrade revascularization fails, retrograde access offers another endovascular option to treat critical limb ischemia before going to open vascular surgery, especially in high surgical risk patients. When both popliteal and pedal approaches are available, pedal access procedure is more preferable as it is relatively easier with less puncture-site complication.

Keywords:
pedal, popliteal, retrograde, superficial femoral artery

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Introduction

Peripheral artery disease (PAD) is a serious medical problem, especially in diabetic and elderly patients. When progressing to critical limb ischemia (CLI), it carries 25% risk of mortality and 25% risk of amputation over the next year [1].

Femoropopliteal lesions are the most commonly diseased segments, making more than 50% of all PAD cases and are characterized by long and diffuse chronic total occlusions (CTOs) [2]. Treatment is technically challenging with relatively poor outcome when compared with short lesions, as it carries high failure rate, especially when the lesion involves the ostium of superficial femoral artery (SFA) [3].

Endovascular intervention has been increasingly used in patients with Trans-Atlantic Inter-Society Consensus (TASC) C and D femoropopliteal lesions [2]. Many reports appreciated its effectiveness because of its lower morbidity and reasonable results compared with bypass surgery [4]. Long lesions of SFA can be managed successfully through antegrade approach. However, 13–25% of these lesions cannot be recanalized because of inability to re-enter the distal true lumen [5]. Re-entry devices are sometimes

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successful, but they are expensive and not applicable all the time, with high failure rate [6].

When antegrade angioplasty fails, retrograde approach offers another backup option for recanalization [7]. Combined antegrade and retrograde approach provides success rates of ~85% in selected patients with long CTO [8]. Retrograde endovascular intervention, either popliteal, tibial, or pedal access, is safe and effective alternative in patients who cannot be revascularized through the standard approach [9].

Popliteal access needs repositioning of the patient during the procedure and carries the risk of puncture-site complications, which remain as drawbacks of this type of popliteal access [7].

Pedal access was described first by Iyer in the 20th century. Several series have shown that it is technically effective [10]. Kwan *et al.* [11] appreciated this technique and reported that it is feasible, safe, and can avoid many complications seen with other approaches.

Patients and methods

This prospective study was carried out from January 2016 to April 2019 at Sohag University Hospitals. A total of 118 patients underwent endovascular interventions for long SFA occlusive diseases in Sohag University Hospitals. Of these patients, 30 underwent retrograde access either transpopliteal or transpedal approach after failed antegrade intervention. All patients had CLI, Rutherford categories 4 and 5.

Inclusion criteria were patients with CLI, SFA occlusive disease with at least one tibial vessel run-off to the foot. The occlusion did not reach the adductor canal. Exclusion criteria were patients with non salvageable limbs, life-threatening infection requiring major amputation, or those with ulcer at the area of intended puncture.

All patients were admitted and signed a written informed consent. This series was approved by hospital ethical committee. Patients were assessed clinically, including history of risk factors such as diabetes mellitus, smoking, hypertension, cardiovascular, cerebrovascular diseases, and renal insufficiency and previous endovascular intervention or bypass surgery. All patients were examined carefully including level of occlusion, Rutherford category, ankle brachial pressure index, and foot examination including the ischemic lesion and its extension. Duplex ultrasound (US) and computed tomography angiography were performed in all the cases. All patients were subjected to full laboratory investigations with special concern to renal functions and coagulation profile.

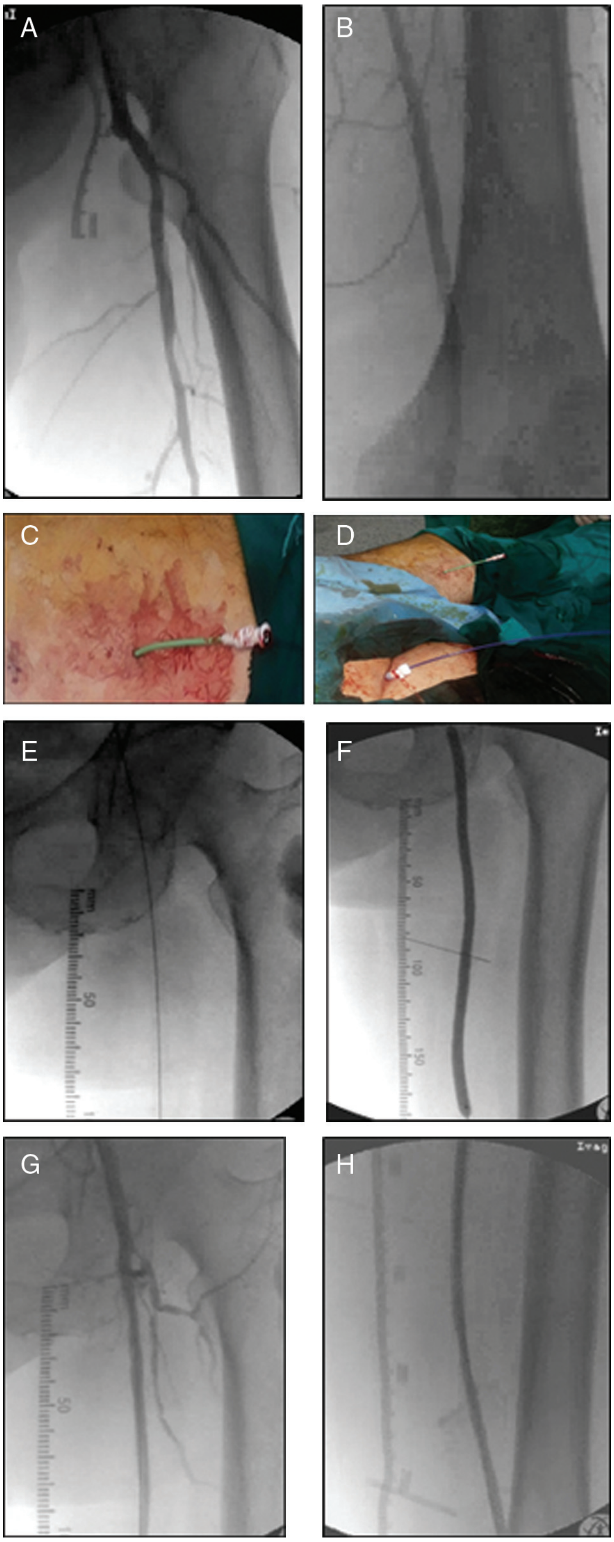
Procedure details included preprocedural medications with dual antiplatelet therapy in the form of salicylates 75 mg and clopidogrel 300 mg as a loading dose followed by daily maintenance dose of 75 mg clopidogrel continued postoperatively for at least 3 months in all cases. The procedure was done under local anesthesia in all cases. The procedure started traditionally by ipsilateral or contralateral femoral access according to the proximal end of SFA lesion. Overall, 70–100 U/kg of unfractionated heparin was injected intra-arterially after sheath insertion. Pre-intervention angiography was performed to assess lesion characteristics: length, extension, and distal run-off vessels.

The lesion was first tackled from above using 0.035 guide wire (J-tip hydrophilic guide wire; Terumo, Tokyo, Japan) and 4-Fr vertebral catheter. The guide wire was tapped repeatedly at the proximal end of the occlusion hoping to be crossed intraluminally or attained a *U* shaped configuration in the subintimal space. Failed attempts to engage the lesion or failed re-entry after subintimal angioplasty was the indication for combined antegrade retrograde approach, for example, popliteal or pedal approaches. Patients were selected for popliteal access in the presence of healthy accessible popliteal segment and stenosed or calcified tibial arteries, whereas were selected for pedal approach in the presence of patent, noncalcified vessels compared with popliteal artery.

Procedure of popliteal access

Knee was slightly flexed and internally rotated (Fig. 1). The ipsilateral popliteal artery was retrogradely punctured under US guidance either in longitudinal or transverse probe position. Color flow duplex was used to identify the flow inside the target artery and then color mode was switched to B-mode, and the needle puncture (18 G needle) was done under US guidance. The true lumen was confirmed by back bleeding from the needle. An angiogram through the dilator was done before starting the retrograde technique. Sheathless approach was the preferable technique to minimize vessel trauma at the puncture site. Sheath was used in certain circumstances, for example, difficult advancement of tools, sharp angulation at the entry site especially in obese

Figure 1



(a, b) CTO of left SFA with distal run-off at P1 popliteal artery, (c) accessing the popliteal artery above the knee with dilator insertion, (d) catheter through contralateral femoral access to advance the retrograde wire inside it, (e) wire crossing the whole lesion and advanced through femoral access, f: balloon dilatation, (g, h) Completion angiography. CTO, chronic total occlusion; SFA, superficial femoral artery.

patients, or balloon predilation was needed through the retrograde access.

Procedure of pedal approach

Certain positioning of the foot during the access was needed (Fig. 2). Plantar flexion was needed when accessing the dorsalis pedis or anterior tibial artery (ATA), whereas eversion and dorsiflexion in accessing posterior tibial artery (PTA).

Both PTA and ATA were successfully punctured under fluoroscopic guidance or US guidance. Overall, 100-μg nitroglycerin was injected intra-arterially to avoid vessel spasm during the procedure.

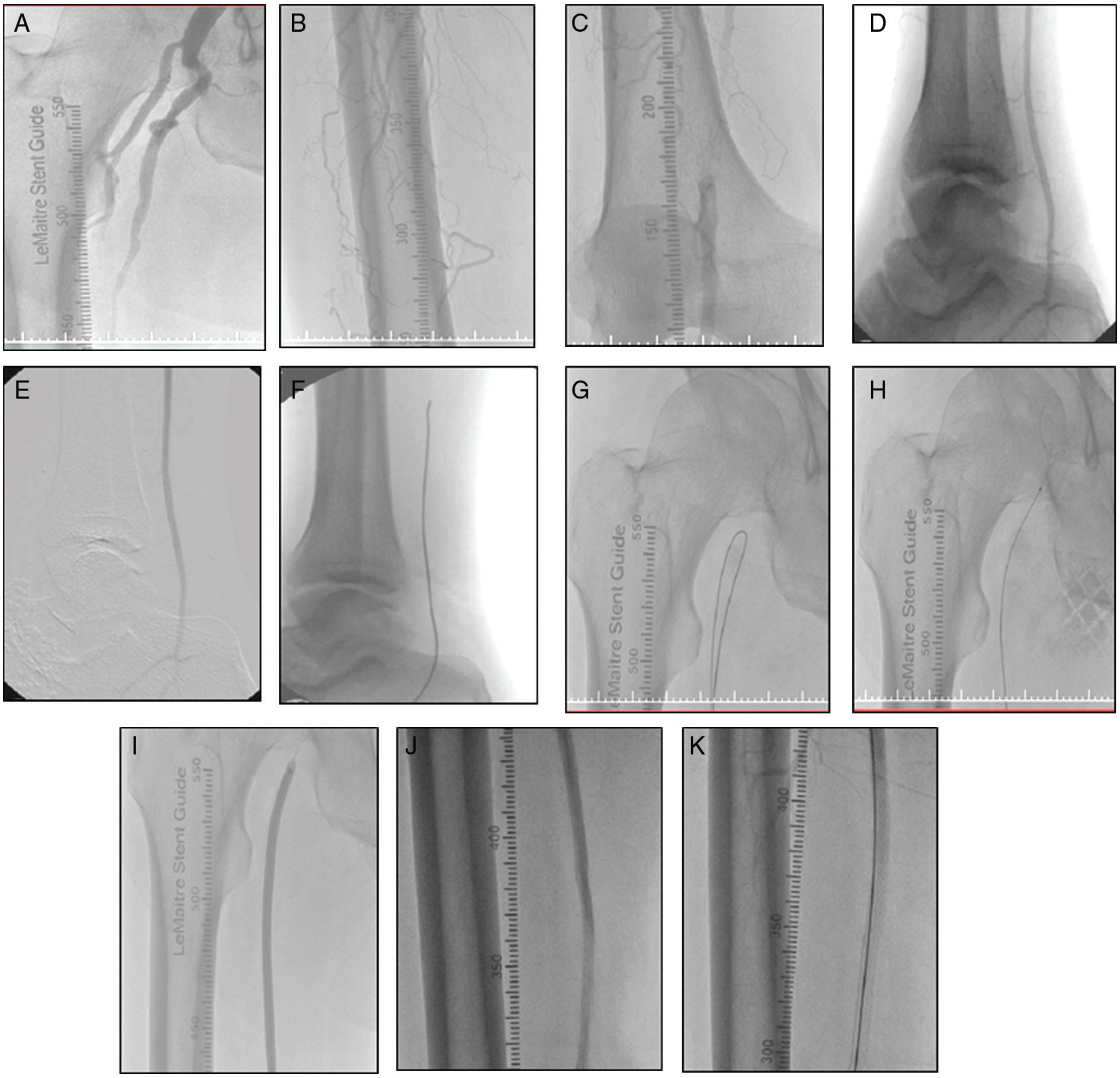
Sheathless access was performed in most cases, but in some cases, a standard kit sheath (radifocus introducer II; Terumo) with 20-G needle was used, as well as 0.018 guide wire (V-18 Control Wire; Boston Scientific, Massachusetts, USA) was used when difficult manipulation. The wire was retrogradely advanced and manipulated to be maintained inside the true lumen until reaching the distal end of the occlusion.

Wire was supported with low-profile balloon or supporting catheter. Intraluminal recanalization was tried hardly but subintimal passage of the wire was sometimes unavoidable until crossing the occlusion. Once the occluded segment was recanalized and wire became inside the true lumen, attempts were made to advance the guide wire into the femoral sheath using antegrade vertebral catheter. Then the antegrade catheter was advanced over the distal wire until reaching a healthy portion. The guide wire was released from the distal access, extracted from femoral sheath, and then reintroduced into the catheter with its soft tip advanced distally.

If antegrade and retrograde wires pass subintimally and were parallel to each other and had no cross-road or were not adjacent, double-balloon technique was used (as described by Schmidt *et al.* [12]), in which two balloons 5 mm were advanced from antegrade and retrograde directions just above the occlusion. Balloons were positioned with a distance between their tips of not more than 5 mm. Cautions should be taken not to overlap the balloons and wires pulled back inside the balloons. Balloons were inflated simultaneously aiming to disrupt the intimal layer separating the balloons from each other. After deflating the balloons, wire advancement was attempted again from both directions until succeeding to be passed intraluminally.

Balloon angioplasty was performed through the antegrade approach. Self-expandable stents were

Figure 2



(a, b, c, d) Totally occluded SFA with distal run-off on short segment P1 popliteal artery and posterior tibial artery, (e) road-map to access puncture, (f) wire seen inside PTA, (g, h) wire crossed the SFA lesion and re-entry to true lumen, (i) balloon dilation, (j) flow-limiting dissection, (k) completion angiography after stent deployment. PTA, posterior tibial artery; SFA, superficial femoral artery.

implanted in cases of flow-limiting dissection or residual stenosis more than 30% after balloon angioplasty.

An appropriate-sized balloon was positioned at the site of distal puncture and inflated. In the meantime, manual compression was maintained for 5–10 min until hemostasis was achieved. Completion angiography was done to assess arterial patency especially at the distal access site before removal of the proximal wire.

All patients underwent duplex US on the day after the procedure to assess patency of the target lesion, rule out any complications related to the procedure, and record any observed access-site complications. Patients were followed up for 3 months postoperatively. During the hospital stay, patients with ischemic ulcers or gangrene received standard wound care, debridement, and/or minor amputation.

During follow-up visits, patients were assessed regarding technical safety, regaining pulse, ankle brachial index, disappearance of rest pain, and access-related drawbacks.

(1) Technical success was defined as achieving successful percutaneous access into popliteal artery or pedal vessel followed by crossing the lesion in a retrograde manner.
(2) Retrograde puncture was considered successful when the retrograde access occurred without inducing local dissection or arteriovenous fistula at puncture site.

(3) Vessel perforation or access-site hematoma was considered minor complications.

The study end point was technical success and procedure-related complications.

Statistical analysis

Descriptive statistics were used to present continuous data as mean±SD. Categorical variables were expressed as numbers and percentages. Continuous variables were compared using Mann–Whitney test. *P* values less than 0.05 were considered statistically significant.

Results

A total of 30 patients underwent combined antegrade retrograde intervention after failed antegrade approach for management of CLI, Rutherford categories 4 and 5, caused by CTO of SFA. In 14 patients, popliteal access was performed, whereas pedal puncture was performed in 16 patients. Pedal puncture was performed through PTA, ATA, and dorsalis pedis artery in 62.5, 31.2, and 6.3%, respectively. The commonest risk factors were diabetes mellitus, smoking, and hypertension in both groups. In popliteal access group, mean age was 57 (50–64) years, and eight (57.1%) patients were males. In pedal access group, mean age was 63 (52–65) years, and nine (56.3%) patients were males. Baseline characteristics are shown in Table 1. There were no significant differences between the two groups.

Lesion length of SFA was 17.1±2.7 and 15.2±3.6 cm in popliteal access and pedal access groups, respectively. The commonest site of the ischemic wound/ulcer was toes in 21/30 (70%) patients and plantar area in 9/30 (30%) patients (Table 2).

Arterial puncture was successful in pedal access than in popliteal access [93.8% (15/16 patients) vs. 92.9% (13/14 patients), *P*=0.96]. Popliteal puncture was difficult and more time consuming especially in obese patients and when it was superimposed by the vein. The most accessible pedal puncture site was PTA.

Table 1 Demographic data and risk factors

	Popliteal approach (*N*=14) [*n* (%)]	Pedal approach (*N*=16) [*n* (%)]
Age (years)	57 (50–64)	63 (52–65)
Males/females	8 (57.1)/6 (42.9)	9 (56.3)/7 (43.7)
Risk factors		
DM	9 (64.3)	12 (75)
Smoking	8 (57.1)	10 (62.5)
Hypertension	8 (57.1)	9 (56.3)
Ischemic heart disease	6 (42.9)	8 (50)
Stroke	3 (21.4)	3 (18.75)
Renal insufficiency	2 (14.3)	2 (12.5)

DM, diabetes mellitus.

Table 2 Lesion criteria and intraoperative data

	Popliteal approach (*N*=14) [*n* (%)]	Pedal approach (*N*=16) [*n* (%)]
Lesion length (cm)	17.1±2.7	15.2±3.6
Rutherford classification		
Rutherford category 4	6 (42.9)	7 (43.8)
Rutherford category 5	8 (57.1)	9 (56.2)
Site of ischemic lesion		
Toes	10 (71.4)	11 (68.8)
Planter area	4 (28.6)	5 (31.2)
Approach		
Contralateral approach	9 (64.3)	10 (62.5)
Ipsilateral approach	5 (35.7)	6 (37.5)
Run-off vessels		
1	2 (14.3)	1 (6.3)
2	9 (64.3)	10 (62.5)
3	3 (21.4)	5 (31.2)
Pedal access puncture		
Posterior tibial access	–	10 (62.5)
Anterior tibial access	–	5 (31.2)
Dorsalis pedis access	–	1 (6.3)

Technical success was higher in patients with pedal access than those with popliteal puncture [87.5% (14 patients) vs. 78.6% (11 patients), P=0.19]. Wire was passed intraluminally in 15 (50%) patients and subintimal in 10 (33.3%) patients. Causes of failure in both groups were re-entry failure in three patients, perforation of SFA within the occlusion segment in one patient, and failed accessing the popliteal artery in one patient. Four patients were treated by femoropopliteal bypass surgery, and major amputation was done in one patient owing to disappearance of distal run-off vessels.

Successful recanalization was achieved by balloon angioplasty in most of the cases through the femoral approach. Self-expandable stents were implanted in 4 cases owing to flow-limiting dissection.

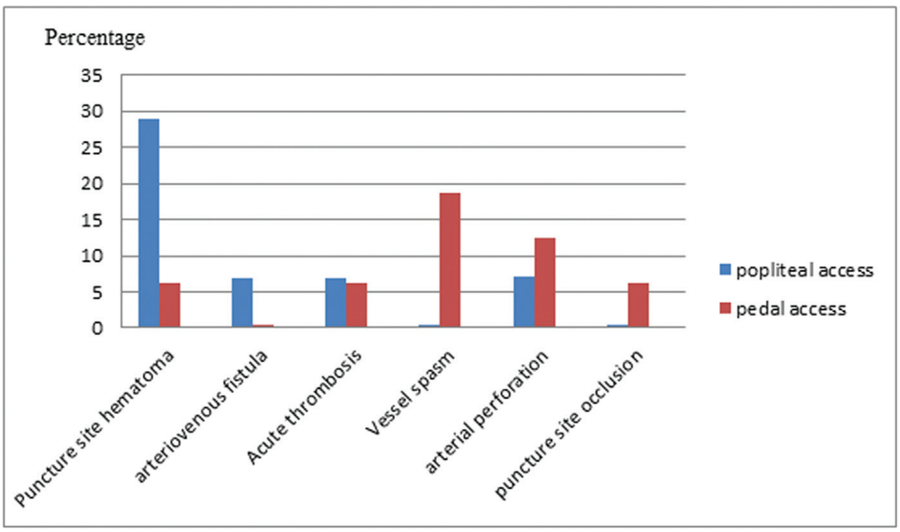
Operative time was shorter in pedal access than popliteal access (90±35, 120±28 min), and it was statistical different (P=0.04). Time to achieve hemostasis was different between the two groups: 12 ±4.6 and 5±1.7 min in popliteal and pedal access, respectively (P=0.022). Debridement was done in nine patients, minor amputation in seven patients, and major amputation was performed in one patient (Table 3).

Regarding procedure-related complications, access-site hematoma and pseudoaneurysm formation were higher in popliteal access group than pedal access group (28.6 vs. 6.3%, respectively), with a significant P value of 0.042. Spasm of pedal vessels during repeated attempts of puncture occurred in 3/16 (18.8%) patients and were managed by injection of mixed lidocaine and diluted verapamil around the vessel, and re-attempt after few minutes helped to relieve the spasm and complete the procedure. Acute thrombosis of SFA occurred in 2/30 (6.7%) patients and was treated by rTPA thrombolysis in one patient and surgical thrombectomy in another. Access-site occlusion occurred in 6.3% (one patient of the pedal approach) and was relieved by balloon inflation. Wire perforation during puncture and extravasation had occurred in two (12.5%) patients of pedal access and one (7.1%) patient of popliteal access. They were discovered intraoperatively by contrast leakage and were treated conservatively by balloon inflation at perforation site associated with external compression for 3 min. It did not affect subsequent performance of the technique. Repeated angiogram after successful recanalization revealed disappearance of the contrast leakage. Death occurred in 2/30 (6.7%) patients within first month postoperative not related to the procedure but from associated patients' comorbidities (Fig. 3 and Table 4).

Table 3 Study outcomes

	Popliteal approach (N=14) [n (%)]	Pedal approach (N=16) [n (%)]	P value
Puncture success	13 (92.9)	15 (93.8)	0.96
Technical success	11 (78.6)	14 (87.5)	0.19
Mean operative time (min)	120±28	90±35	0.04
Time to achieve hemostasis (min)	12±4.6	5±1.7	0.022

Figure 3



Procedure-related complications.

Table 4 Complications

	Popliteal approach (*N*=14) [*n* (%)]	Pedal approach (*N*=16) [*n* (%)]
Puncture-site hematoma	4 (28.6)	1 (6.3)
Arteriovenous fistula	1 (7.1)	0
Acute thrombosis	1 (7.1)	1 (6.25)
Arterial spasm	0	3 (18.8)
Arterial perforation	1 (7.1)	2 (12.5)
Access-site occlusion	0	1 (6.3)

Discussion

CLI increases among population older than 50 years and has approximately double this rate after 70 years old, especially in diabetic patients [4].

TASC II guidelines recommended open vascular surgery for TASC C and D lesions, although these patients had multiple comorbidities and had limited life expectancy than patients with TASC A and B [13]. Baril *et al.* [14] compared endovascular management and femoropopliteal bypass for TASC D patients and concluded that the difference was not statistically significant regarding primary and secondary patency rates.

Endovascular intervention has become the first line of treatment for symptomatic PAD, as it increases tissue perfusion and improves limb salvage rate and quality of life. Recanalization of long CTOs remains a technical challenge. Its success rate is variable and differs by variation of techniques and procedures. Subintimal angioplasty of SFA occlusion whether antegrade or retrograde is effective and widely used, but in some circumstances, its results may be unfavorable, for example, procedure failure (14–24%) and vessel perforation [5,15]. Common causes of failure result from inability to re-enter the true lumen, ostial SFA occlusion, and wire perforation within the occlusion. Repeated attempts and trials can extend the subintimal channel and leads to disruption of vital collaterals and therefore worsen the ischemia with devastating clinical results. It seems to be wise and beneficial to spare the segment above the occlusion for bypass surgery if needed. This fright might add another reason of retrograde subintimal failure. Re-entry device was designed to solve this situation. They perform quite well, but in certain circumstances, outback catheter is not available all the time and its failure rate can reach up to 35% [16,17].

Retrograde approach is used frequently as an effective technique to facilitate procedural success [18]. It is known that occlusion cap at its proximal end of occlusion is more fibrous, calcified, and resistant to wire negotiation in comparison with the distal end. Thus, the wire can be advanced retrogradely with less difficulty [1]. In addition, the occlusion cap is convex and smooth from above, so guide wire coming antegrade may slide over the cap entering the subintimal space or failed crossing [19].

In this series, 14 popliteal accesses was performed, whereas pedal puncture was accessed in 16 patients. Popliteal artery, ATA, PTA, and dorsalis pedis artery are used for retrograde access. The choice between popliteal and pedal accesses depends on which one is the most suitable and accessible. For example, popliteal access is not suitable for patients who cannot be placed in prone or in lateral decubitus positions, or patients whose popliteal artery and vein are superimposed to each other [16]. Pedal access is not suitable in presence of ulcers at the entry zone [20]. Cautions should be taken in cases when there is only one patent infrapopliteal artery to avoid damage to the only distal run-off vessel [5].

In this series, popliteal access was performed in the medial aspect of the thigh under US guidance. Multiple approaches of popliteal access were reported. Each has its advantages and limitations. Tønnesen was the first in reporting the popliteal technique two decades ago [7]. However, the need for repositioning the patient during the procedure and the potential risk of access-site complications held back this procedure. Prone positioning makes the intervention performed through single access only at any time. The adjoining artery and vein at popliteal fossa increase the potential risk of puncture-site complications, for example, arteriovenous fistula, pseudoaneurysm, or large hematoma after the removal of the popliteal sheath. Schmidt *et al.* [12] created popliteal technique in supine position, and the puncture site was into the medial aspect of the thigh using fluoroscopic guidance. This technique avoids patient's mobilization from supine to prone and takes the advantages of performing the intervention by dual directions, that is, antegrade and retrograde approaches at the same time. Shi *et al.* [21] operated patients in supine position and accessed the popliteal artery below the knee caudal to the semimembranosus muscle. Ye *et al.* [5] created the puncture site 8–10 cm below the medial condyle of femur and parallel to the posteromedial border of the tibia. They appreciated their choice of infracondylar area because it is the standard site for surgical exposure of the distal popliteal artery.

Pedal access is a recent advancement in vascular interventions when the antegrade approach is not possible [10]. El-Sayed *et al*. [22] recommend plantar flexion in accessing dorsalis pedis or ATA, eversion and dorsiflexion in puncturing PTA. Pedal puncture in this study was performed through PTA, ATA, and dorsalis pedis artery in 62.5, 31.2, and 6.3%, respectively, with the majority of cases through PTA. Mustapha *et al*. [23] reported that PTA was chosen in most cases owing to its straight nature in puncture area and more superficial and accessible in comparison with ATA. Hua *et al*. [16] reported that retrograde access of pedal vessels is not usually easy, and its repeated attempts extended the operative time and increase vessel spasm. Successful access was confirmed by back bleeding or visualizing the tip of the needle within the lumen of the artery. Pedal access has two barriers of concern that might be considered as factors of failure: uncertain ability to access such small vessels and the fear of destroying the vessel at access site which might result in thrombosis and deterioration of the clinical condition [10]. Thus, the best chance to access the pedal artery was the first or second trial, otherwise spasm would occurred and hematoma around the vessel might preclude the puncture. Many series reported that arterial spasm at access site is very common, and therefore, liberal use of vasodilators, for example, nitroglycerin, is effective during the procedure [22]. In this series, pedal spasm occurred in three (18.8%) cases and was relieved by nitroglycerin. Liang *et al*. [24] performed routine surgical cut-down approach on tibial vessels for retrograde access to overcome the drawbacks of percutaneous puncture and concluded that it may be considered as another option to gain retrograde access in high-risk patients.

In this study, popliteal puncture was performed under US guidance in all cases, whereas in pedal access punctures, 13 (81.3%) patients were punctured under US guidance and three (18.75%) cases were performed by using of road-map technique. Variant methods of guidance for popliteal artery puncture have been reported in literature, particularly, US guidance, Doppler-equipped needle, and road-map guidance [19]. Fluoroscopic guidance is used frequently since its description in the past decade by Botti *et al*. [25]. It requires certain positioning of the radiograph tube and image intensifier. Arterial puncture can be performed in real time during contrast injection or in road-map fashion. US-guided puncture would be a reasonable alternative to road-map guidance, as it minimizes the amount of contrast required, reduces radiation exposure to the interventionist, avoids the needle puncture through accompanying vein, and then reduces the risk of arteriovenous fistula [12].

In this series, popliteal access was performed as a sheathless access in 10 (71.4%) patients and with sheath in three (21.4%) patients and failed access in one patient. Ye *et al*. [5] reported that using sheath in popliteal approach increases the risk of puncture-site complications. In pedal access, most patients were managed without sheath, whereas in two (12.5%) patients, radifocus II sheath was used owing to difficulty in advancing and manipulating tools.

In this series, 100-μg nitroglycerin was routinely injected intra-arterially through the dilator before advancement of the wire to overcome the spasm of tibial vessels. Palena *et al*. [26] reported a new pharmacological solution, 5 mg/2 ml of verapamil diluted in 10 ml saline. Overall, 9 ml of this solution was injected intra-arterially, and 1 ml of diluted verapamil solution together with lidocaine is injected around the vessel in subcutaneous tissue. Mustapha *et al*. [23] created TAMI solution (tibiopedal arterial minimally invasive solution), which is composed of 500 ml heparinized saline mixed with 1600 mg nitroglycerin and 5 mg verapamil. It is infused via the side port of the sheath as a continuous vasodilatation for tibial vessels.

Balloon angioplasty was performed within the femoral approach in all cases of this study after successful crossing of the wire. Self-expandable stents were implanted in four cases owing to flow-limiting dissection. This strategy was matched with others [22].

In this series, achievement of hemostasis was performed by balloon inflation across the distal puncture site associated with external compression for 5–10 min. Schmidt *et al*. [12] appreciated this maneuver, as balloon dilatation without external compression may induce arterial dissection, access-site pseudoaneurysm, or later cause intimal hyperplasia. Yilmaz *et al*. [27] reported that only 3–10 min of manual compression seemed to be enough to obtain complete hemostasis without any complication.

Technical success was achieved in 78.6% (11 patients) in popliteal procedure, whereas it was 87.5% (14 patients) in pedal access approach among patients of this series. Spreen *et al*. [28] and Noory *et al*. [29] evaluated transpopliteal recanalization of long SFA occlusions and achieved technical success rate of 83 and 98.2%, respectively. Technical failure in this study was recorded in 21.4% in popliteal puncture and 12.2% in pedal access. Causes of failure in both groups were re-entry failure, perforation of SFA within the occlusion segment, and failed access. Taha *et al*. [30] reported technical failure in 42.6%. Differences in technical success rates among series can be attributed to skill variations and learning curve of puncture of such small and calcified vessels. Walker [31] had confirmed that technical success variation was due to absence of a standard protocol for retrograde interventions.

Retrograde wire passed intraluminally in 15 (50%) patients and subintimally in 10 (33.3%) patients among cohorts of this series. Ghoneim *et al*. [4] reported that technical success was a statistically significant different in transluminal group (94%) compared with the subintimal group (62.5%). Similar results were recorded by Mc Carthy *et al.* [32]. However, in a more recent systematic review, Met *et al.* [33] reported success rates between 80 and 90% when subintimal angioplasty was used.Regarding popliteal puncture-site complications, considerable hematoma occurred in four (28.6%) patients. One of them was large, ~8×5 cm in size, and required surgical evacuation and repair of puncture site, whereas others were treated conservatively. Small arteriovenous fistula occurred in one (7.1%) patient, which did not require intervention. Noory *et al*. [29] reported 10.7% popliteal puncture-site complication rate. Yilmaz *et al.* [27] reported two major complications requiring surgical intervention (large hematoma resulting in a neurological deficit and 7-cm pseudoaneurysm) and were treated surgically.

Regarding pedal puncture-site complications, small hematoma occurred in one (6.3%) patient at anterior tibial access and treated conservatively. Access-site occlusion was observed in another patient (6.3%) and treated with balloon inflation and nitroglycerin injection. Spasm of tibial vessels was observed in three (18.8%) patients. No arteriovenous fistula or pseudoaneurysm was observed. Kwan *et al*. [11] reported that occlusion rate for pedal access appeared to be sufficiently low. Montero-Baker *et al*. [34] had reported one access-site occlusion and two perforations and hematomas in their series.

Literatures had reported arterial wall dissection with subsequent thrombosis at the access site. Although rare, it is a shocking complication that affects limb salvage. A variety of techniques were used to limit this risk either by using small-caliber sheath, 3 or 4 F, using dilator only, or using sheathless access to keep the access site as small as possible [20]. Recent advanced tools facilitated the procedure, for example, micropuncture pedal access kit, pedal micropuncture sheath, and micro balloon catheter, which improved the performance and reduced the risk of access-site complications [22].

Amoroso *et al*. [35] used the pedal artery puncture as a single access via a new ultralow profile 6-F sheath with an outer diameter of 2.4 mm, equivalent to 5 F sheath and inner lumen of 2.2 mm that can accommodate 6-F equipment to perform SFA angioplasty and stenting and reported its feasibility as a primary access. They assumed that the larger the sheath, the greater the trauma to small-caliber vessel and therefore the higher potential for access-site complication.

Retrograde access procedure is relatively effective and safe. It expanded the options for endovascular revascularization after failed antegrade approaches in complex SFA lesions. It reserves the option of open surgical procedures as a future option later on when needed, especially in the presence of several patient comorbidities. However, it should be used only for limb salvage in cases of CLI as using this approach in claudicants with single run-off vessel to the foot carries a real risk of destroying this only artery to the foot and result in limb loss in someone who was not initially at risk.

Conclusion

When antegrade revascularization fails, retrograde access offers another endovascular option to treat CLI before going to open vascular surgery, especially in high surgical risk patients. When both popliteal and pedal approaches are available, pedal access procedure is more preferable as it is relatively easier with less puncture-site complication.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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