

Role of Retrograde Transpopliteal Angioplasty for Superficial Femoral Artery Occlusion

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ABSTRACT

Background: surgical interventions are indicated for patients with peripheral arterial disease (PAD) who developed CLI or debilitating IC that is refractory to conservative management; while bypass, with an autologous vein or prosthetic conduit, is the mainstay of open surgical management of PAD. On the other hand, the percutaneous endovascular interventions has emerged as an alternative effective, and safe, treatment option in patients with PAD. **Objective:** the aim of the study was to evaluate the effectiveness and safety of the retrograde popliteal approach for recanalization of long segment occlusion of superficial femoral artery in cases with chronic lower limb ischemia.

Patients and Methods: this is a prospective study conducted on 30 patients presenting to Al-Azhar University Hospitals and Mataria Teaching Hospital; all of them have chronic lower limb ischemia due to proximal long segment occlusion of superficial femoral artery (SFA) after failure to pass through the antegrade access either by the ipsilateral or by the contralateral femoral approach.

Results: ankle brachial index (ABI) is a commonly used surrogate marker of atherosclerosis. In the present study, the rate of complications was relatively low (16.7%) in which pseudoaneurysms were encountered in 10% and arteriovenous fistulae were encountered in 6.7% of the patients.

Conclusion: retrograde popliteal approach is feasible, safe, and effective technique for the management of CTO of superficial femoral artery in patients with failure of pass through the antegrade access either by the ipsilateral or by the contralateral femoral approach.

Keywords: PAD, SAF, CTO.

INTRODUCTION

Patients with lower extremity peripheral artery disease (PAD) experience substantial functional disability due to claudication, rest pain, and the loss of tissue integrity in the distal limbs. The number of patients requiring lower limb revascularization for limb ischemia is likely to increase significantly worldwide as a result of aging populations, the increasing prevalence of diabetes, and the failure so far to significantly reduce global tobacco consumption⁽¹⁾.

Lower extremity occlusive disease may range from exhibiting no symptoms to limb-threatening gangrene. There are two major classifications developed based on the clinical presentations, the Fontaine classification and the Rutherford classification. The Fontaine classification uses four stages: Fontaine I, II, III, and IV. The Rutherford classification has four grades (0-III) and seven categories (0-6). These clinical classifications help to establish uniform standards in evaluating and reporting the results of diagnostic measurements and therapeutic interventions⁽²⁾.

Endovascular specialists who treat patients with advanced symptomatic peripheral arterial disease are commonly faced with long segments of complex TASC D or chronically occluded lesions, especially in the superficial femoral artery (SFA). SFA chronic total occlusions (CTOs), especially in

the ostial location, present the greatest operator challenge⁽³⁾.

The principle reasons for procedural failure are the inability to remain intraluminal during crossing the CTO segment, and re-entering the true lumen. There is also an associated risk of perforation dissection, and creation of arteriovenous fistulas⁽⁴⁾.

In about 20 to 30% of the cases standard techniques including the cross-over and the antegrade approach fail to cross total superficial femoral artery occlusions. In these cases, the transpopliteal technique can be used as secondary approach after failed cross-over recanalization. Furthermore, long superficial femoral artery occlusions without visible patent proximal stump can be recanalized using this technique⁽³⁾.

The primary success rate of EVT for SFA CTO has improved from 75% in 2001) to 81%–94% in 2014) EVTs for SFA are generally managed by the antegrade approach, which uses a contralateral retrograde puncture or ipsilateral antegrade puncture of the common femoral artery. Alternatively, the popliteal approach is less frequently utilized⁽⁵⁾.

Complex peripheral chronic total occlusions require persistent innovation regarding access, options, and equipment. Understanding the available techniques of subintimal angioplasty along with familiarity with reentry devices allow

safe and successful recanalization of SFA occlusions.⁽⁶⁾

AIM OF THE WORK

The aim of the study is to evaluate the effectiveness and safety of the retrograde popliteal approach for recanalization of long segment occlusion of superficial femoral artery in cases with chronic lower limb ischemia.

PATIENTS AND METHODS

This is a prospective study conducted on 30 patients presenting to Al-Azhar University Hospitals and Mataria Teaching Hospital; all of them have chronic lower limb ischemia due to proximal long segment occlusion of superficial femoral artery (SFA) after failure to pass through the antegrade access either by the ipsilateral or by the contralateral femoral approach.

Written informed consent:

An approval of the study was obtained from Al-Azhar University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of the operation.

All patients were presented with:

- Chronic lower limb ischemia Rutherford categories 3, 4, 5 and 6 (ischemic rest pain, unhealed foot ulcers and gangrene of one or more of the toes).
- All patients have SFA occlusion (no stump or stump > 1 mm).
- All the arterial lesions were TASC D classification.
- For whom surgery (bypass) couldn't be done (as first choice) either due to unfitness, poor distal run off, distal infection or refusal by the patient himself to undergo surgery.
- All the patients underwent endovascular intervention for the SFA occlusion.
- Patient gender, demographics, presence of comorbidities, history of smoking, indication for intervention and the use of anticoagulation therapy will be recorded. The procedure, possible complications, benefits, risks and other alternative interventions were all explained to the patients and an informed consent was obtained.

Methods:

(I) Clinical assessment: History taking and clinical examination.

(II) Pre-procedural investigations:

- Routine laboratory tests.
- Duplex scanning.
- CT angiography.
- Echocardiography only for patients with history of cardiac disease.
- X ray foot (if there is foot ulceration or gangrene).

All the procedures were done in fully equipped angiosuite under complete aseptic techniques.

(III) Technique of retrograde transpopliteal angioplasty:

All procedures were performed in a fully equipped angiosuite under complete aseptic techniques. All patients were given a 300-mg loading dose of clopidogrel, 6 hours or less before the procedure.

With patients in the supine position, access to the SFA lesion was achieved from the contralateral or ipsilateral femoral artery, or occasionally from the brachial artery when neither femoral access is available. After the sheath placement, 5000 units of heparin were administered.

In all cases, antegrade recanalization was initially attempted from the retrograde contralateral femoral artery, through an antegrade ipsilateral approach, or occasionally from the brachial artery. However, when recanalization proved to be impossible owing to inability to cross the lesion or inability to re-enter the true lumen distal to the occlusion. Therefore, a medial retrograde popliteal access at the infracondylar plane was adopted. The most suitable puncture point is where the popliteal artery is visualized without superimposition of the vein, which is usually proximal and medial to the knee joint.

The patients were remained supine, with the lower extremity in a 60 degree external rotation and the knee in a gentle flexion. An angiogram via the proximal sheath was performed to confirm the suitable level for distal PA puncture and to obtain a roadmap to visualize the popliteal artery.

In accordance with the standard surgical approach for the distal PA, the puncture site was determined beforehand 8-10 cm below the border of the medial condyle of the femur and parallel with the posterior medial border of the tibia for 1 cm. Puncture was performed with a 21-gauge micropuncture needle, obliquely from caudal to cranial.

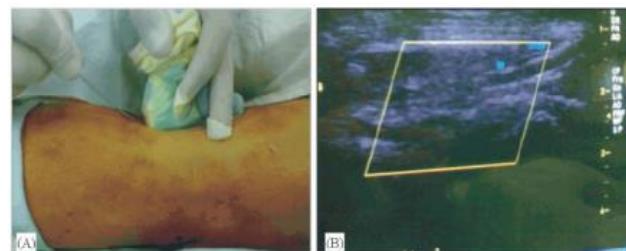


Figure (1): A. Popliteal puncture under US guidance **B.** Successful needle puncture

When the needle tip is visualized inside the popliteal artery lumen, a 0.018- or 0.035-inch, 180-cm angle-tipped standard hydrophilic guide wire will be advanced into the distal patent portion of

the SFA. The guidewire was inserted through the needle followed by a 6-Fr, 10-cm sheath.

Once retrograde passage of the occlusion was successful 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 gentle manual compression at the popliteal puncture site after popliteal sheath removal.

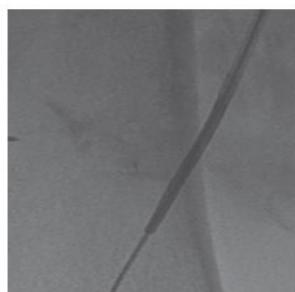


Figure (2): Balloon angioplasty

The patency of the popliteal artery access site was checked by angiography from the antegrade femoral approach. Finally, the antegrade femoral sheath was removed if the popliteal access site is patent, and the distal access site was covered with a circular bandage for 4 hours.

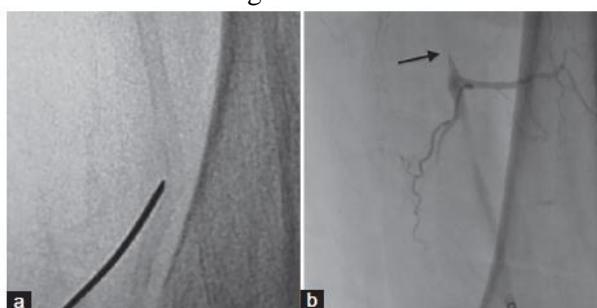


Figure (3): The retrograde transpopliteal approach

The patients were maintained on clopidogrel (75 mg/d) for 12 weeks, and then aspirin (100 mg/d) was prescribed as a continuous therapy.

Postoperative follow up:

Follow-up visits were scheduled at one week, one month, 3 months, 6 months, 9 months, and 12 months regarding clinical evaluation and duplex ultrasound.

Statistical analysis

Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean \pm standard deviation (SD). Qualitative data were expressed as frequency and percentage.

The following tests were done:

- Independent-samples t-test of significance was used when comparing between two means.
- Chi-square (χ^2) test of significance was used in order to compare proportions between two qualitative parameters.
- The confidence interval was set to 95% and the margin of error accepted was set to 5%. The p-value was considered significant as the following:
- Probability (P-value):
 - P-value <0.05 was considered significant.
 - P-value <0.001 was considered as highly significant.
 - P-value >0.05 was considered insignificant.

RESULTS

The present study included 30 patients who experienced failure of pass through the antegrade access either by the ipsilateral or by the contralateral femoral approach at Al-Azhar University Hospitals and Mataria Teaching Hospital.

Table (1): Age distribution among studied cases (n=30)

		Age
Mean		65.13\pm3.69
Range		(60.0-73.0)

Table (2): Sex distribution

Sex		N	%
	Male	22	73.3
	Female	8	26.7
	Total	30	100.0

The majority of patients were males (73.3 %) with a mean age of 65.13 ± 3.69 years old.

Table (3): Patients characters and risk factors

		N	%
Smoking	Not smoking	10	33.3
	Smoking	20	66.7
DM	Non	18	60.0
	Diabetic	12	40.0
HTN	Not	17	56.7
	Hypertensive	13	43.3
CHD	NO	24	80.0
	CHD	6	20.0
Hyper-cholesterolemia	No	14	46.7
	Yes	16	53.3
	Total	30	100.0

Table 3 shows the majority of the patients had one or more risk factors for PAD including diabetes (40%), hypertension (56.7%), smoking (66%), and IHD (20%).

Table (4): Pre-operative complication

	N	%
No	25	83.3
Pseudo-aneurysm	3	10.0
Fistula	2	6.7

In this table the rate of complications was relatively low (16.7%) in which pseudoaneurysms was encountered in 10% and arteriovenous fistula was encountered in 6.7% of the patients.

Table (5): Patency

	N	%
PATENCY _6M	No	6
	Yes	24
PATENCY _1YEAR	No	7
	Yes	23
	Total	30
		100.0

Table 5 shows the primary patency rate in the present study was 80% at six months and 76.7% at one year of follow-up.

Table (6): Association between patency and patients characters and risk factors

		PATENCY 1YEAR		Total	X ²	P		
		No	Yes					
Sex	Male	N	7	15	22	3.32	0.06	
		%	100.0%	65.2%	73.3%			
	Female	N	0	8	8			
		%	0.0%	34.8%	26.7%			
Smoking	No	N	0	10	10	4.56	0.033*	
		%	0.0%	43.5%	33.3%			
	Yes	N	7	13	20			
		%	100.0%	56.5%	66.7%			
DM	No	N	4	14	18	0.031	0.86	
		%	57.1%	60.9%	60.0%			
	Yes	N	3	9	12			
		%	42.9%	39.1%	40.0%			
HTN	No	N	2	15	17	2.93	0.087	
		%	28.6%	65.2%	56.7%			
	Yes	N	5	8	13			
		%	71.4%	34.8%	43.3%			
CHD	No	N	4	20	24	2.98	0.084	
		%	57.1%	87.0%	80.0%			
	Yes	N	3	3	6			
		%	42.9%	13.0%	20.0%			
Hyper-cholesterolemia	No	N	0	14	14	7.98	0.005*	
		%	0.0%	60.9%	46.7%			
	Yes	N	7	9	16			
		%	100.0%	39.1%	53.3%			
Total		N	7	23	30			
		%	100.0%	100.0%	100.0%			

Significant association between failure and smoking also significant association with hypercholesterolemia

Table (7): Comparison

	Patent	Not	t	P
Age	64.78±3.42	66.28±4.49	-0.941	0.355
SFA	96.14±5.11	96.38±1.52	-0.120	0.905
ABI_PRE	0.48±0.054	0.47±0.07	0.601	0.553
ABI_POST	0.72±0.04	0.6±0.0	7.544	0.000

Patent Significantly higher regard ABI post.

DISCUSSION

In our study, the majority of patients were males (73.3 %) with a mean age of 65.13 ± 3.69 years old. The current body of evidence suggested that male aged between 55 and 74 years are more likely to develop PAD than general population⁽⁷⁾. In a large UK registry study, 66% of a total of 473 included PAD patients were males with a mean age of 68 ± 10 years old⁽⁸⁾. On the other hand, **Mao et al.**⁽⁹⁾ study that included 7,568 adult patients with PAD and reported that 62% were males with higher mean age than our study (71.3 ± 12 years old). This discrepancy can be attributed to the difference in the severity of the disease between our cohort and Moa cohort.

PAD patients carry a high burden of risk factors and co-morbidities. The development of atherosclerotic PAD is a multifactorial process involving both modifiable and non-modifiable risk factors which include: old age, black ethnicity, smoking, diabetes, hypertension, and other risk factors⁽¹⁰⁾. In the present study, the majority of the patients had one or more risk factors for PAD including diabetes (40%), hypertension (56.7%), smoking (66%), and IHD (20%). **Khan et al.**⁽⁸⁾ reported that 40% of the PAD patients within the UK registry were smokers and 55% of them had hypertension or hypercholesterolemia.

Regarding our primary outcomes, the primary patency rate in the present study was 80% at six months and 76.7% at one year of follow-up. Our association analysis showed that the primary patency rate at one year was significantly lower among smokers, patients with hypocholesterolemia, and patients with low postoperative ABI.

In concordance with our findings, **Ye et al.**⁽¹¹⁾ performed a prospective study on 19 patients with CTO of the superficial femoral artery who underwent transpopliteal procedures after failure of an antegrade procedure. The technical success was achieved in all cases and the primary patency at 6 months was 84.2%.

Similarly, **Eweda et al.**⁽¹²⁾ recruited 26 patients with chronic SFA occlusion who underwent percutaneous recanalization from a retrograde popliteal access. The results showed that the technical success was achieved in all cases. Moreover, the primary patency was 80.7% at 6 months and 76.9% at 1 year.

Moreover, **Ueshima et al.**⁽⁵⁾ performed a retrospective study on 91 patients with CTO of superficial femoral artery who underwent retrograde popliteal approach. The authors reported a notable higher patency rate (97%) than our results.

The exact causes of such difference in success rates between our results and **Ueshima et**

al.⁽⁵⁾ study are unclear. However, it can be attributed for differences in sample size, study design, and procedure's characteristics. In terms of procedural characteristics in our cohort, the double balloon stent was necessary in 40% of the patients; while the 4 Fr sheath and 6 Fr sheath were used in 33.3% and 26.7% of the patients respectively. In contrary, **Ueshima et al.**⁽⁵⁾ used 3 Fr sheaths or microcatheters. It was reported that the use of lower-diameter puncture instruments, such as 3 Fr sheaths or microcatheters, instead of the conventional 4–6 Fr sheaths, has improved the clinical outcomes and the rates of complications⁽¹³⁾.

On the other hand, ankle brachial index (ABI) is a commonly used surrogate marker of atherosclerosis. The ABI is the preferred initial screening test to help diagnose and grade the obstruction of PAD in the legs. Besides the diagnostic role, ABI has a prognostic role, identifying patients with very high cardiovascular risk, independently of the presence or absence of symptoms⁽¹⁴⁾. Therefore, a significant improvement in the ABI postoperatively can denote technical success and good prognosis.

In the study, the ABI showed a statistically significant increase following the retrograde popliteal approach. In agreement with our findings, **Ye et al.**⁽¹¹⁾ reported that the mean ABI increased significantly from an initial 0.41 ± 0.18 at admission to 0.94 ± 0.12 at discharge following retrograde popliteal approach.

Similarly, **Eweda et al.**⁽¹²⁾ showed that ABI increased from 0.5 ± 0.2 preoperatively to 0.7 ± 0.1 , with improvement in the walking distance. Additionally, **Younes et al.**⁽¹⁵⁾ reported that there was a 40% increase in actual ankle-brachial index (ABI); 93% of patients achieved an ABI rise >0.15 after retrograde popliteal approach.

As mentioned before, the retrograde popliteal approach can be associated with wide range of complications such as dissections, arterial ruptures, arteriovenous fistula, pseudoaneurysms, bleeding, and hematomas⁽¹⁶⁾. In the present study, the rate of complications was relatively low (16.7%) in which pseudoaneurysms was encountered in 10% and arteriovenous fistula was encountered in 6.7% of the patients.

In line with our findings, **Noory et al.**⁽¹⁷⁾ performed a retrospective study 2002 to 2007 on 56 patients with stable chronic PAD (Rutherford category 2 to 5) who had failed antegrade subintimal angioplasty and turned into retrograde popliteal approach. The authors reported that the rate of complications was 10.6% in which 5.3% of the patients experienced groin hematomas and one patient had fistula.

Similarly, **Fanelli et al.**⁽¹⁸⁾ performed a prospective study on 26 patients with intermittent claudication and chronic SFA occlusion who underwent percutaneous recanalization from a retrograde popliteal access. Two small hematomas were found in the popliteal region, but no pseudoaneurysm or arteriovenous fistulas were seen on duplex examinations during a mean 12.5-month follow-up (range 6–28).

CONCLUSION

Retrograde popliteal approach is feasible, safe, and effective technique for the management of CTO of superficial femoral artery in patients with failure of pass through the antegrade access either by the ipsilateral or by the contralateral femoral approach. The retrograde popliteal approach achieved a clinically relevant primary patency rate with low incidence of complications. Nevertheless, further large-scale studies are still needed to confirm our findings.

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