Al-Azhar International Medical Journal

Volume 5 | Issue 3 Article 13

2024
Section: General Surgery

Retrograde Popliteal Artery Access in peripheral Arterial Angioplasty in Management of Superficial Femoral Artery and Proximal Popliteal Artery Occlusive Lesions

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How to Cite This Article

Ismail, Abd El Fattah Ali; Zakaria, Mohamed Yahia; and Mustafa, Mohammed Mustafa Taha (2024) "Retrograde Popliteal Artery Access in peripheral Arterial Angioplasty in Management of Superficial Femoral Artery and Proximal Popliteal Artery Occlusive Lesions," *Al-Azhar International Medical Journal*: Vol. 5: Iss. 3, Article 13.
DOI: https://doi.org/10.58675/2682-339X.2317

ORIGINAL ARTICLE

Retrograde Popliteal Artery Access in Peripheral Arterial Angioplasty in Management of Superficial Femoral Artery and Proximal Popliteal Artery Occlusive Lesions

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Abstract

Background: **Most peripheral artery disorders of the lower extremities are caused by femoropopliteal atherosclerotic disease. Femoropopliteal bypass surgery is the first-line revascularization method suggested for TASC-D superficial femoral artery (SFA) occlusions. Nonetheless, substantial success rates with endovascular therapy (EVT) in TASC-D lesions are made possible by recent advancements in endovascular technology.**

Aim: **To assess the safety and efficacy of the retrograde popliteal access (RPA) approach as a first line of treatment for recanalization of proximal popliteal artery lesions and SFA occlusive lesions in patients with critical lower limb ischemia.**

Patients and methods: **This study is prospective and was carried out from January 2020 to January 2022 on 60 patients who presented to Military Armed Forces Hospitals and Al-Azhar University Hospitals.**

Result: **Patients with proximal lesions of the SFA without a stump, significant obesity, and common femoral artery stenosis or blockage were found to benefit most from the RPA approach.**

Conclusion: **Our results demonstrate that recanalization of SFA complete blockage with proximal popliteal artery (PA) lesion can be achieved safely and effectively using the US guided RPA endovascular method. We propose that, in endovascular treatment of SFA chronic total occlusion with proximal PA lesion, US guided RPA access can be employed as a first choice, not just in situations where the antegrade strategy failed.**

Keywords: Occlusive lesions, Peripheral arterial angioplasty, Popliteal artery, Retrograde popliteal artery

1. Introduction

The global prevalence of peripheral arterial disease (PAD) is steadily rising, and advancements in technology have led to improved outcomes in endovascular interventions for superficial femoral artery (SFA) lesions. In 2001, the success rate for such treatments was reported to be 75%, which increased to ~94% by 2014. Currently, the preferred approach for treating SFA lesions is antegrade, utilizing either the ipsilateral or contralateral femoral arteries.[1]

The management of SFA occlusions typically involves the use of antegrade ipsilateral or contralateral femoral approaches. In cases where these approaches are unsuccessful, retrograde popliteal access (RPA) is considered as an alternative. Initially, the use of RPA was limited and served as a backup option due to associated complications. However, with the development of various guidance methods for popliteal artery (PA) puncture, such as ultrasound (US) guidance and digital subtraction angiography (DSA), the RPA technique has become safer and is now often the preferred choice in

Accepted 25 November 2023.
Available online 7 June 2024

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https://doi.org/10.58675/2682-339X.2317

patients with common femoral artery stenosis or occlusion, proximal lesions of SFA without a stump, severe obesity, diseased aorta, and multilevel iliac-SFA lesions.[2]

When the antegrade approach for treating disease in the SFA is not feasible due to extensive disease or complete blockage of the SFA origin, alternative treatment options include retrograde access through the ipsilateral limb's popliteal artery. This approach may be advantageous in cases of isolated SFA or proximal popliteal disease due to the larger vessel size and proximity to the targeted lesion. Consequently, it allows for better support and maneuverability during endovascular repair. As a result, using RPA access has been deemed a safe method for treating occlusions in the femoral and popliteal regions when access through the common femoral artery (CFA) is not possible.[3]

In recent literature, there has been documentation regarding the viability and practicality of utilizing popliteal puncture in a supine position, with the leg slightly flexed and internally rotated, employing micro-access sets. Due to the proximity to the popliteal vein, it is advisable to employ ultrasound guidance to prevent transvenous punctures, which carry the potential risk of arteriovenous (AV) fistulae. This recommendation is particularly relevant in cases where femoral access has already been established. The visualization of PA anatomy can be achieved through the administration of contrast material, which aids in guiding the puncture. This technique offers a comprehensive understanding of the vascular anatomy, allowing for the identification of any PA diseases that may complicate the access site. Additionally, the process of vessel puncture can be guided using road mapping.[4]

The objective of this study is to assess the efficacy and safety of utilizing the RPA approach as the primary method for restoring blood flow in situations with SFA occlusive lesions accompanied by proximal popliteal artery lesions in individuals experiencing critical lower limb ischemia.

2. Patients and methods

This study is a prospective investigation carried out on a cohort of 60 patients who sought medical attention at Al-Azhar University Hospitals and Military Armed Forces Hospitals from January 2020 to January 2022.

Inclusion criteria: this study includes individuals of both genders (male and female) who are adults (aged 18 years or older) who have good renal function (with a serum creatinine level below 1.5). The individual's potential allergic reaction to contrast agents is currently unknown. They exhibit critical lower limb ischemia categorized according to the Rutherford classification system as stages 3, 4, 5, and 6, which correspond to ischemic rest pain, unhealed foot ulcers, and gangrene affecting one or more toes. Additionally, they present with symptomatic atherosclerotic occlusive lesions in the SFA along with proximal popliteal artery lesions. At least one artery below the knee remains patent, allowing uninterrupted blood flow to the pedal arch. Prior to the procedure, the individual's resting ankle-brachial pressure index (ABPI) in the affected limb is equal to or less than 0.6. Furthermore, they have provided informed consent for the study.

Exclusion criteria: the patient exhibits impaired renal functions with a serum creatinine level exceeding 1.5. They also have a documented allergy to contrast agents. Additionally, the patient presents with acute limb ischemia, asymptomatic chronic limb ischemia, significant lesions in the iliac artery, a significant disease affecting all three infrapopliteal vessels, a nonsalvageable foot, and contraindications to both anticoagulation and antiplatelet therapy.

2.1. Patients selection considerations

Patients selected for RPA access angioplasty of SFA occlusion with proximal popliteal artery lesions should fulfill the relevant clinical criteria. Documentation should include:

A written medical history including: the medical record should include a comprehensive account of the patient's presenting symptoms, the rationale for the procedure, the patient's medical and surgical history, a detailed inventory of current medications, information regarding any known allergies, and an assessment of vascular risk factors.

Physical examination including: the evaluation of the affected limb includes assessing pulses, ABPI, skin lesions, and conducting a comprehensive examination to rule out alternative medical conditions.

Investigations are represented by: the diagnostic procedures employed in this study encompassed laboratory assessments, including a complete blood picture, kidney function tests, and coagulation profile, as well as radiographic examinations, such as Duplex ultrasonography or computed tomography angiography.

2.2. Procedure

The diagnostic procedures employed in this study encompassed laboratory assessments, including a complete blood picture, kidney function tests, and coagulation profile, as well as radiographic

examinations, such as Duplex ultrasonography or computed tomography angiography.

Anesthesia: all cases were done under local anesthesia.

Access: RPA access ultrasound guided as first choice as distal as possible into healthy part of popliteal artery mostly second and third part of popliteal artery.

Positioning: the majority of instances (93.33%, n = 54) were patients positioned in the prone position, which facilitated convenient access to the popliteal artery within the popliteal fossa. A total of four instances, accounting for 6.67% of the sample, were seen in a supine posture. In these cases, the lower extremity was positioned in a 60° external rotation, while the knee was maintained in a little flexion.

Intervention: in the majority of cases, the patient was positioned in the prone position, while in a minority of cases, the supine position was used with the lower extremity externally rotated at a 60° angle and the knee gently flexed. The P2 or P3 segment of the popliteal artery was then punctured under the guidance of ultrasound. The area posterior to the knee joint was examined using B-mode ultrasound. During the examination, the muscles around the popliteal fossa were successfully identified, and the PA and vein were distinguished by analyzing their ultrasonographic characteristics and employing a straightforward compression technique. Following the administration of local anesthetic utilizing 1% lidocaine hydrochloride, the puncture of the PA was performed using a standard 21-gauge puncture needle under the direction of ultrasound imaging.

When the needle tip was visualized within the PA and arterial blood was aspirated, the guidewire of the sheath was inserted, and the needle was removed and a 6-F sheath inserted then the guidewire removed. Following the placement of the sheath, a total of 5000 units of unfractionated heparin were administered via intra-arterial route. Subsequently, the contrast media was administered, allowing for visualization of the vessel, hence facilitating the identification of the occluded portion.

A hydrophilic wire with a diameter of 0.035, known as the BERN catheter, was utilized to navigate through the blocked portion and reach the common femoral artery (CFA). After the successful crossing of the lesion, an angiography was conducted to confirm the accurate placement of the catheter within the actual lumen. Subsequently, balloon angioplasty was carried out utilizing a 5 × 200 mm balloon. Stenting was reserved for cases where residual stenosis or flow-limiting dissection was observed. Angiograms were conducted after to angioplasty procedures. Following the intervention, the sheath and catheters were extracted, and hemostasis was accomplished with the application of manual pressure.

Duration of each procedure ranged from 30 to 90 min. Equipment used (sheath size was 6 F sheath, guiding wire type was 0.035 hydrophilic Trumo wire, guiding catheter used was BERN catheter, balloon size was 5 × 200 mm and stent size was varied in each case (8 cases). Compression bandage of puncture site for 6–8 h was done.

2.3. Medications

Peri-procedure includes: Anticoagulant drugs must be stopped, clopidogril loading does 300 mg must be taken 6 h before the procedure, intravenous antihistaminic just before the procedure to avoid contrast hypersensitivity, and good hydration with N-acetyl cysteine to secure the kidneys.

Intraprocedure includes: Heparin bolus 5000IU (70–100 U/kg) after insertion of the sheath.

Postprocedure includes: Aspirin 100 mg/day, clopidogril 75 mg/day for 3–6 months and statins (Atorvastatin) 20 mg/day.

2.4. Study end point

Technical success is defined as achieving successful percutaneous access into popliteal artery followed by crossing the lesion in a retrograde manner. Retrograde puncture is considered successful when the retrograde access occurred without inducing local dissection or arteriovenous fistula at puncture site. Clinical success is defined by relief of symptoms and signs of ischemia with improved ABPI and vascularization. Peri-procedure complications in our study were flow limiting dissection and arterial restenosis after ballooning which was managed by stenting. No access site complications were in our study.

2.5. Patient follow-up

Patients were evaluated at 1, 3, and 6 months postprocedure regarding the duplex US or CTA showing patent SFA, sustained clinical improvement (symptoms improvement, intact popliteal pulse, healing of the lesion and improved ABPI), monitoring of kidney functions and control of risk factors (smoking, D.M and hyperlipidemia).

2.6. Statistical analysis

The data that was collected was evaluated utilizing the Excel software, specifically the Microsoft Office 2016 version. Continuous data are typically represented using the means accompanied by the standard deviation, while categorical data are typically expressed as percentages. A one-sample *t*-test was employed to compare continuous variables. The significance of the *P* value was determined as follows: a *P* value less than 0.05 was deemed statistically significant, a p-value less than 0.001 was regarded very statistically significant, and a *P* value more than 0.05 was considered statistically insignificant.

3. Results

The sample for this study consisted of 60 individuals who had complete occlusion of the SFA together with concurrent disease in the proximal PA.

3.1. Demographic data

The patient age ranged from 40 to 75 years old as in Fig. 1 with the mean age 65.5 ± 9.4 years (Mean ± SD) while 80% of our patients were male patients as in Fig. 2.

3.2. Risk factors

In our study 28 (46.67%) patients were smoker, 20 (33.33%) patients were hypertensive, 50 (83.3%) patients were diabetic, 32 (53.3%) patients were hyperlipidemic, and 34 (56.67%) patients of our study were cardiac Fig. 3.

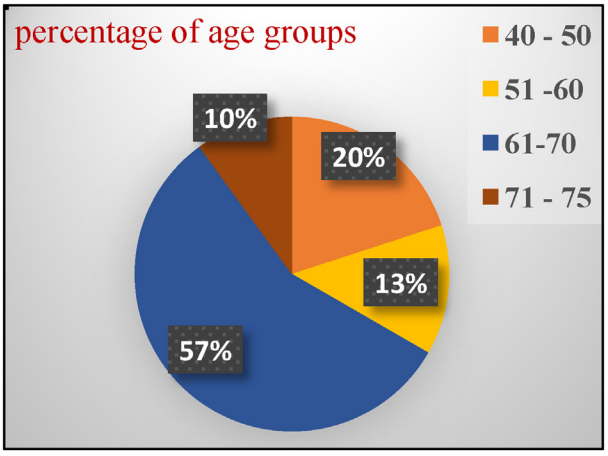

Fig. 1. Shows the percentage of age groups.

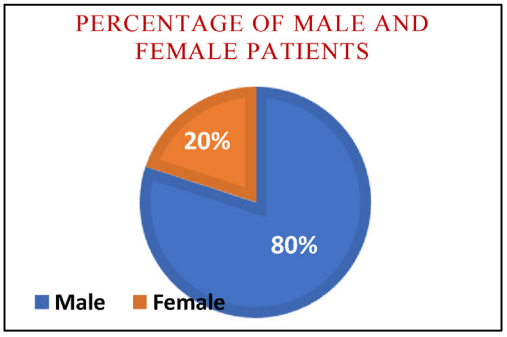

Fig. 2. Shows the Percentage of male and female patients.

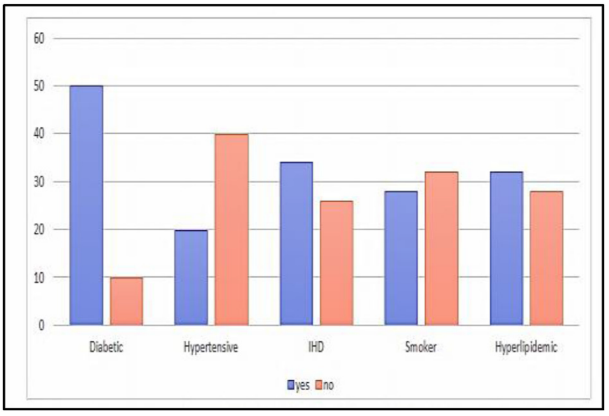

Fig. 3. Shows the risk factors.

3.3. Rutherford category (presentation)

Figure 4.

The study observed that 3.33% of patients exhibited severe claudication pain, classified as Rutherford category three. Additionally, 30% of patients experienced ischemic rest pain, categorized as Rutherford category four. Ischemic ulcers or minor tissue loss, classified as Rutherford category

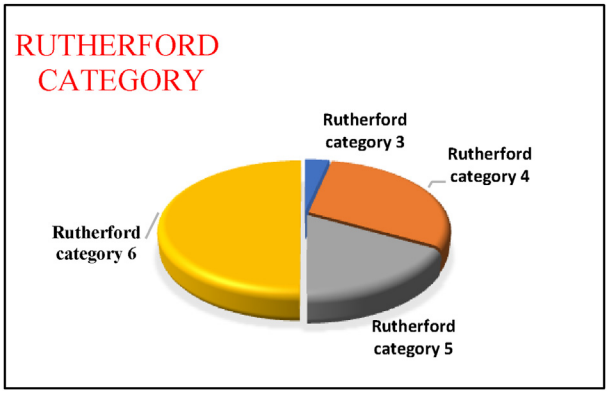

Fig. 4. Shows the rutherford category.

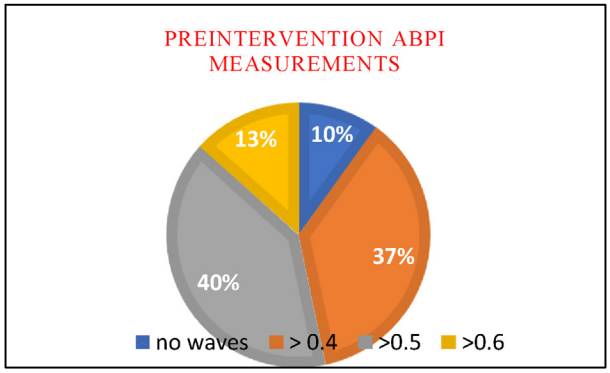

Fig. 5. Shows the pre-intervention ankle-brachial pressure index measurements.

five, were present in 16.76% of patients. Finally, major tissue loss, categorized as Rutherford category six, was observed in 50% of patients.

3.4. Preintervention ABPI measurements

Patients with no Doppler waves percentage was 10% (6 patients), patients with ABPI less than 0.4 was 36.67% (22 patients), patients with ABPI less than 0.5 was 40% (24 patients), and patients with ABPI 0.6 was 13.33% (8 patients) Fig. 5.

3.5. Technical success

Table 1.

Us guided retrograde popliteal puncture was successful in all patients with no access site complications. Technical failure in our study (6 cases) was due to failure to re-enter to true lumen (6 cases). Complications occurred in 10 cases, 8 cases were due to dissection with flow limiting flap and were managed successfully with stenting, and 2 cases were due to restenosis of proximal SFA and re-intervention was done with stenting, no systemic or life-threatening complications.

4 cases did not regain distal pulses in spite of technical success due to single peroneal artery as distal run off (2 cases) and postoperative proximal SFA re-stenosis which confirmed by arterial duplex so re-intervention done with stenting.

Success rate was high 90% (50 cases) with *P* value less than 0.001 which is significant result. The patency rates at 1, 3, and 6 months after intervention were 100, 96, and 71%, respectively Fig. 6, Tables 2 and 3.

3.6. Follow–up results

After 1 month, there were 10 patients already without distal pulses as six patients failed, two patients regain PA pulse with PA runoff and two patients have no pulses in spite of technical success due to restenosis. So, no new patients lost distal pulses after one month of the procedure. After 3 months, two patients lost distal pulses. After 6 months, 14 more patients lost distal pulses. So, total patients with no distal pulses after the procedure are 26, 10 immediately after the procedure, two after 3 months and 14 after 6 months Figs 7 and 8.

4. Discussion

In our investigation, a significant proportion of the patient population consisted of males (80%), a finding consistent with the aforementioned study of Khalil[5] where 85% of patient were males and the study of Kuserli and Kavala[1] where 76.3% of patients were males. With mean age 65.5 ± 9.4 years old which is in the same mean age range of the study of Khalil and Ozcan[6] where the mean age was 64 ± 9 and the study of Elhaieg *et al.*[7] where the mean age was 65 ± 3.

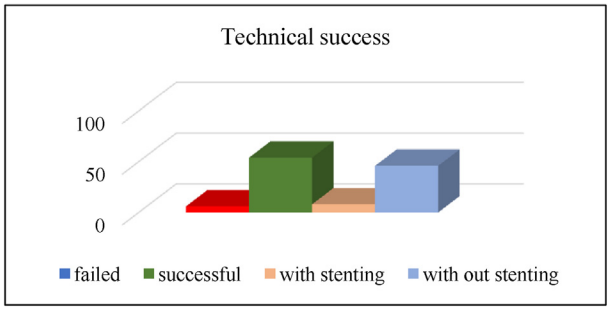

Fig. 6. Shows the technical success.

Table 1. Shows the technical success.

Technical success					
Access 100% success US guided		Crossing the lesion		Stenting	
Prone Number (%) 54 (93.33) *P* value <0.001	Supine Number (%) 4 (6.67)	Success Number (%) 54 (90) <0.001	Failed Number (%) 6 (10)	With Number (%) 8 (14.8) <0.001	Without Number (%) 46 (85.2)

Table 2. Comparison between success and failure rates in relation to age, sex, risk factors, Rutherford category and preintervention ankle-brachial pressure index.

	Success ($N = 54$) [n (%)]	Failure ($N = 6$) [n (%)]	P value
Age			
40–50	12 (22.2)	0	
51–60	8 (14.8)	0	0.043356
61–70	28 (51.9)	6 (100)	
71–75	6 (11.1)	0	
Sex			
Male	44 (81.5)	4 (66.67)	0.374334
Female	10 (18.5)	2 (33.33)	
Risk Factors			
Smoking	24 (44.4)	4 (66.67)	
HTN	18 (33.3)	2 (33.3)	
DM	44 (81.5)	6 (100)	0.002439
Hyperlipidemia	30 (55.5)	2 (33.3)	
IHD	30 (55.5)	4 (66.67)	
Rutherford category			
III	2 (3.7)	0	
IV	18 (33.3)	2 (33.3%)	0.075752
V	10 (18.5)	0	
VI	30 (55.5)	4 (66.7)	
Pre ABPI			
No waves	6 (11.1)	0	
<0.4	20 (37)	2 (33.3)	0.026656
<0.5	20 (37)	4 (66.7)	
<0.6	8 (14.9)	0	

As regard risk factors and comorbidities, our patients had multiple risk factors such as smoking (47%), hypertension (33%), diabetes mellitus (83%), ischemic heart diseases (34.7%), dyslipidemia (53%) So the main risk factors in our study was diabetes mellitus not like the study of Komshian *et al.*[3] where smoking was the main risk factor (83.1%) and the study of Kuserli and Kavala[1] where smoking also was the main risk factor (76%).

In our study, the majority of the patients have tissue loss (97%) which is the same in the study of Silvestro *et al.*[8] where the majority of the patients have tissue loss.

Site of lesion in our study which was in SFA with proximal popliteal artery lesion as in the study of Khalil and Ozcan[6] and the study of Silvestro *et al.*[8]

In our study all the patients were TASC D, as in the study of Elhaieg *et al.*[7]

As regard position of the patient during RPA access, the majority on our study were in prone position (93.33%) while the other 6.67% were in supine position. As in the study of Hayakawa *et al.*[9] there were 24 patents in prone position and 20 patients in supine position. While in the study of Silvestro *et al.*[8] and Elhaieg *et al.*[7] were in supine position.

As regard access site, in our study access was through popliteal artery as first choice as in the study of Kuserli and Kavala[1] and Khalil *et al.*[5] While in the study of Khalil and Ozcan[6] was RPA as 1st choice in 20 patients and after failure of antegrade in 23 patients.

In our study, complications rate (dissection in 8 cases and restenosis in 2 cases) was 16.6% which in the same average in the study of Silvestro *et al.*[8] (14.6%) and the study of Elhaieg *et al.*[7] (16.7%).

Table 3. Shows the clinical success.

Clinical success						
Symptoms relief		Distal pulse		Follow-up		
No	Yes	No	Yes	1 m	3 ms	6 ms
Number (%)	Number (%)	Number (%)	Number (%)	Number of patient (Lost distal pulses)	Number of patient (Lost distal pulses)	Number of patient (Lost distal pulses)
6 (10)	54 (90)	10 (16.7)	50 (83.3)	0	2 (3.7)	14 (5.9)
P value						
<0.001		<0.001		–	<0.001	0.05864447

Fig. 7. Shows the clinical success.

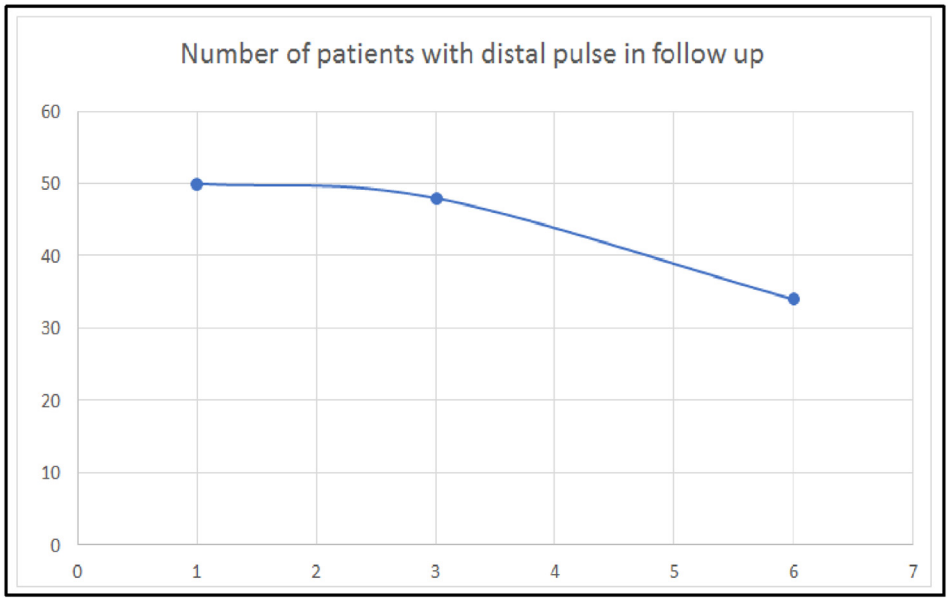

Fig. 8. Number of patients with distal pulse in follow-up.

As regard success rate, our study success rate was 90% which is in the study of Kuserli and Kavala[1] (92.4%).

In our study, primary patency rate after 6 months was 71% which is in the same average in the study of Komshian *et al.*[3] (70.3%), Elhaieg *et al.*[7] (76.7%) and Kuserli and Kavala[1] (72.1%).

4.1. Conclusion

The results of our study demonstrate that the utilization of the US guided RPA endovascular approach in the recanalization of SFA total blockage with proximal PA lesion is both a safe and successful procedure. It is recommended that the

utilization of guided US RPA be considered as the primary option for endovascular intervention in cases of SFA chronic total occlusion (CTO) accompanied by a proximal PA lesion. This recommendation extends beyond situations where the antegrade approach has proven unsuccessful.

Conflicts of interest

No conflict of interest.

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