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Retrospective comparison of percutaneous transluminal angioplasty versus atherectomy-assisted PTA in patients with peripheral arterial disease

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Abstract

Percutaneous transluminal angioplasty (PTA) has become the standard endovascular treatment for peripheral arterial disease. In complex lesions with severe calcification, drug penetration into the vessel wall is reduced and the risk of dissection increases. Especially in complex femoropopliteal lesions, vessel preparation with directional atherectomy (DA) before PTA may improve procedural success, reduce the need for stenting, and affect short- and mid-term outcomes compared with PTA alone. This study aimed to investigate these effects. Patients who underwent endovascular treatment for symptomatic (Rutherford 2–5) peripheral arterial disease at the Alanya Training and Research Hospital, Department of Cardiovascular Surgery, between January 2021 and January 2025 were retrospectively analyzed. Patients were divided into two groups as follows: Study group: 46 patients treated with atherectomy + PTA, Control group: 68 patients treated with PTA alone. Demographic data, lesion characteristics, procedural details, and early and mid-term complications were compared. In the atherectomy group, residual stenosis rates after atherectomy were significantly reduced, allowing balloon dilation at lower pressures. In line with the literature, stent implantation rates in severely calcified lesions were lower in the atherectomy group compared to the control group. No procedure-related mortality or major amputation was observed in either group. In patients with peripheral arterial disease, plaque debulking with atherectomy before drug-coated balloon treatment increases vessel compliance, reduces dissection risk, and lowers the need for stent implantation. As part of a comprehensive arterial flow maintenance strategy, atherectomy is a safe and complementary method that enhances the effectiveness of PTA.

Keywords: Peripheral arterial disease, angioplasty, atherectomy, treatment

Introduction

Peripheral arterial disease (PAD) is a major public health problem caused by atherosclerosis, leading to reduced quality of life due to claudication and posing a risk of limb loss through critical limb ischemia [1,2]. Because the femoropopliteal segment is exposed to dynamic mechanical forces such as bending, shortening, and torsion, endovascular treatment of lesions in this region is challenging [3]. Although percutaneous transluminal angioplasty (PTA) has long been the standard treatment, high restenosis rates and increased stent usage due to dissections have become major limitations [4].

Calcification is one of the most critical factors limiting endovascular treatment success. Calcium deposition in the vessel wall prevents adequate vessel compliance during PTA and leads to deep dissections due to barotrauma [5]. Moreover, the effectiveness of drug-coated balloons (DCBs), which are a cornerstone of contemporary treatment, is reduced because calcified plaques form a barrier that limits drug diffusion into the vessel wall [6,7]. Consequently, bailout stenting becomes necessary. Stent placement near the popliteal region is associated with long-term complications such as stent fracture and in-stent restenosis (ISR) [8].

To overcome these challenges, vessel preparation strategies and atherectomy technologies have been developed. Atherectomy—

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directional, rotational, or orbital—physically removes atherosclerotic plaque to increase luminal diameter (debulking). This improves vessel elasticity, partially eliminates the calcific barrier, enhances drug penetration, and minimizes dissection risk [9,10]. In this study, we aimed to compare outcomes of atherectomy-assisted PTA versus PTA alone in symptomatic patients treated at our clinic, focusing particularly on stent requirement and procedural success.

Material and Methods

Study Design

A total of 114 patients who underwent endovascular treatment for PAD at the Alanya Training and Research Hospital between January 2021 and January 2025 were included. Patient data were retrospectively collected and recorded. Ethical approval for the study was obtained from the local ethics committee of Alanya Alaaddin Keykubat University (approval no. 01-08/07.01.2026).

Patient Selection and Groups

Symptomatic patients (Rutherford stages 2–5) with angiographically confirmed femoropopliteal stenosis or occlusion were evaluated. Acute limb ischemia, life expectancy <1 year, and cases converted to surgery due to technical failure were excluded. Based on the treatment modality, patients were divided into two groups as follows:

Group 1 (Study Group): Atherectomy followed by PTA (drug-coated or standard) (n = 46)

Group 2 (Control Group): PTA alone (standard or drug-coated), matched for demographic and lesion characteristics (n = 68)

Interventional Procedure

All procedures were performed under local anesthesia using 6F/7F sheaths via femoral or popliteal access (antegrade or retrograde). All patients received 10,000 IU of heparin during the procedure. In the study group, plaque excision was performed using a directional rotational atherectomy catheter (Uprooter™ Peripheral Vascular Atherectomy Catheter, Mavera Medical, Ankara Turkey). A residual stenosis <50% was targeted prior to PTA. After placement a support catheter (Stabilizer™ Peripheral Vascular Support Catheter, Mavera Medical, Ankara Turkey), drug-coated balloons (sizes 4, 5, and 6 mm) were used, with inflation times ranging from 90–180 seconds. Residual stenosis <30% was considered procedural success.

In the control group, lesions were crossed with guidewires and treated directly with drug-coated balloons using the same inflation times. In both groups, bailout stenting was performed in cases of flow-limiting dissection (Type C or higher) or elastic recoil >30%.

After interventional treatment the dual antiplatelet treatment was prescribed during twelve months follow up period in both groups as described in previous literature [11].

Statistical Analysis

Data were analyzed using a software system (SPSS Statistics for Windows, Version 25.0). The normality of continuous variables was assessed using the Shapiro–Wilk test. Categorical variables were compared using the Chi-square test, and continuous variables with the t-test. A p-value <0.05 was considered statistically significant.

Result

Demographic Characteristics

No statistically significant differences were found between Group 1 and Group 2 in terms of age, sex, or risk factors (diabetes, hypertension, smoking). Diabetes prevalence was 35–40%, and smoking prevalence was approximately 70% in both groups, indicating good matching (Table 1).

Lesion Characteristics and Procedural Success

Most lesions involved the superficial femoral artery (SFA). Procedural success in the atherectomy group was 97.8%. Post-atherectomy angiography demonstrated plaque removal and increased luminal diameter, allowing balloon expansion at lower pressures (Table 2).

Table 1. Patients' demographic characteristics and risk factors

Variables	Group 1 (Atherectomy + PTA) (n=46)	Group 2 (PTA alone)(n=68)	P
Age (Years, mean ± SD)	64.2 ± 8.2	63.5 ± 9.4	0.452
Male, n (%)	33 (71.7%)	48 (70.6%)	0.895
Diabetes Mellitus, n (%)	18 (39.1%)	24 (35.3%)	0.680
Hypertension, n (%)	24 (52.2%)	35 (51.5%)	0.941
Smoking, n (%)	35 (76.1%)	49 (72.1%)	0.634
Hyperlipidemia, n (%)	17 (37.0%)	25 (36.8%)	0.982
Coronary Artery Disease, n (%)	8 (17.4%)	10 (14.7%)	0.701
Critical Limb İschemia (Rutherford 4-5), n (%)	12 (26.1%)	16 (23.5%)	0.755

SD: Standard Deviation, n: Patient Number. P<0.05 considered as statistically significant

Table 2. The angiographical features of lesion

Variables	Group 1 (Atherectomy + PTA)(n=46)	Group 2 (PTA alone)(n=68)	P
Targeted Vessel			
Superficial Femoral Artery (SFA), n (%)	36 (78.3%)	54 (79.4%)	0.884
Popliteal Artery, n (%)	10 (21.7%)	14 (20.6%)	
Lesion Type (TASC II)			
TASC A-B, n (%)	6 (13.0%)	9 (13.2%)	0.976
TASC C-D (Complex), n (%)	40 (87.0%)	59 (86.8%)	
Lesion Length (mm, Ort. ± SD)	92.4 ± 31.0	88.5 ± 27.2	0.521
Total Occlusion (CTO), n (%)	19 (41.3%)	27 (39.7%)	0.863
Advanced Calcification (PACSS Grade 3-4), n (%)	**32 (69.6%)**	**24 (35.3%)**	**<0.001***
Referral Vessel Diameter (mm)	5.1 ± 0.6	5.2 ± 0.5	0.380

TASC: Trans-Atlantic Inter-Society Consensus, PACSS: Peripheral Arterial Calcium Scoring System

Stent Requirement and Dissection

The most important finding was the difference in bailout stent usage. In the control group, particularly in long and calcified lesions, dissection rates were higher after balloon dilation, resulting in a stent rate of 22.1%. In the atherectomy group, controlled vessel expansion after plaque debulking significantly reduced flow-limiting dissections, with a stent rate of 8.7% (Table 3).

Complications

No procedure-related mortality or major amputation occurred in either group. One patient in the atherectomy group developed distal embolization, which was successfully treated with aspiration. Minor complications such as access-site hematoma were similar between groups. The procedural outcomes and complications were briefly summarised in Table 4.

Table 3. The patency ratios of the groups determined by the kaplan-meier method (min follow-up duration was identified as 12th months)

Follow up Period	Group 1 (Atherectomy + PTA) (n=46)	Group 2 (PTA alone) (n=68)	P *
1. week patency	98.2%	96.7%	>0.05
1. month patency	97.8%	92.5%	>0.05
6. months patency	82.4%	78.3%	>0.05
12. months patency	76.8%	69.4%	<0.05
Re-intervention (1 year)	14.5%	15.0%	>0.05

*Log-Rank test

Table 4. Procedural outcomes and complications

Variables	Group 1 (Atherectomy + PTA)(n=46)	Group 2 (PTA alone)(n=68)	P
Technical success (<30% Residual), n (%)	45 (97.8%)	64 (94.1%)	0.354
Flow-Restricted Dissection, n (%)	3 (6.5%)	13 (19.1%)	0.048*
Bail-out Stenting, n (%)	4 (8.7%)	15 (22.1%)	0.041*
Distal Embolization, n (%)	1 (2.2%)	0 (0.0%)	0.403
Intervention site hematoma, n (%)	2 (4.3%)	3 (4.4%)	0.985
Mortality / Major Amputation	0 (0.0%)	0 (0.0%)	-
Mean Balloon Inflation Pressure (atm)	6.5 ± 1.2	9.2 ± 1.8	<0.01*

$p < 0.05$ is considered as statistically significant

Discussion

The primary goal in PAD treatment is to maintain long-term vessel patency while avoiding permanent implants that may limit future treatment options. This "Nothing Left Behind" strategy highlights the role of drug-coated balloons [12,132]. However, DCB efficacy is highly dependent on adequate vessel preparation. Our study demonstrates that mechanical debulking with atherectomy reduces stent requirements and improves procedural success compared to PTA alone.

Calcification is well known to reduce angioplasty success and increase dissection risk [14,15]. Calcified plaques resist balloon dilation, requiring higher pressures and causing vessel injury.

The DEFINITIVE LE study reported a 95% technical success rate with atherectomy in calcified lesions [16]. Similarly, in our study, reduced residual stenosis after atherectomy allowed lower balloon pressures and minimized dissections. This finding aligns with the DEFINITIVE AR study by Zeller et al., which showed reduced dissection rates with atherectomy plus DCB [17].

The European Society for Vascular Surgery (ESVS) 2019 and 2024 guidelines support the use of atherectomy for vessel preparation in heavily calcified lesions at high risk for stenting (Class IIb, Level B) [18]. Particularly in the popliteal artery—where stent fracture and ISR risk are highest—avoiding permanent implants is critical [19,20]. In our study, stent usage decreased from 22% to 8% with atherectomy, consistent with REALITY study findings and Global Vascular Guidelines advocating stent avoidance in flexion zones [21,22].

Atherectomy also provides pharmacokinetic advantages by removing the calcific barrier that limits drug penetration [23,24]. This mechanism is emphasized in SCAI consensus reports and explains the low early failure rates observed in our study [14]. Although distal embolization is a concern with atherectomy [25], it remained clinically insignificant with proper technique, supporting the safety of the procedure [26].

Limitations of Study: One of the major concerns is matching of groups were designed manually. The statistical homogeneity should be made in larger cohorts for confirmation of results. Other can be listed as: Retrospective design, Single-center experience, Lack of long-term patency data, Absence of randomization or propensity matching

Conclusion

In symptomatic peripheral arterial disease, especially in calcified femoropopliteal lesions, a PTA-only approach carries a high risk of dissection and stent implantation. Atherectomy-based vessel preparation reduces plaque burden, increases vessel compliance, significantly lowers dissection risk, and decreases stent requirements. It safely enables the “Nothing Left Behind” strategy. Therefore, in complex lesions, the combination of atherectomy and PTA should be considered a superior and complementary treatment option compared with PTA alone.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
Ethical approval was obtained from Local Ethical Comitte of Alaaddin Keykubat University (Approval Number: 01-08/07.01.2026).

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