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Original Article

Antegrade and retrograde access in the endovascular treatment of femoropopliteal chronic total occlusions

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Abstract

Aim: In this study, the aim was to investigate whether antegrade or retrograde approaches are superior in the endovascular treatment of femoropopliteal chronic total occlusions (CTO).

Material and Methods: A total of 437 patients who were diagnosed with CTO in the femoropopliteal region and who subsequently underwent endovascular procedures between February 2019 and April 2022 were evaluated retrospectively. The patients were grouped as antegrade access and retrograde access. All patients were classified according to the Rutherford and TASC (Transatlantic Intersociety Consensus II) classification. The patients were followed for 2 years. Above-ankle amputation and >50% stenosis in the target vessel were considered a failure. ABI, improvement in clinical symptoms, and limb salvage were evaluated in controls.

Results: Antegrade approach was performed in 218 of the endovascular procedures. Antegrade recanalization was successful in 201 patients (92.2%), and failed antegrade attempt was seen in 17 because the lesion could not be crossed. Retrograde approach was used in 197 of endovascular interventions. Successful retrograde recanalization was unsuccessful in 185 patients (93.9%), and retrograde intervention was unsuccessful in 12 patients because the lesion could not be crossed. When the two-year restenosis numbers were examined, it was 61 (30.3%) in the antegrade group, while it was 49 (25.5%) in the retrograde group, and there was a significant difference between the groups. When the one-year stent occlusions between the groups were examined, it was 14 (6.9%) in the antegrade group and 8 (4.1%) in the retrograde group, and there was a statistically significant difference between the groups.

Conclusion: The retrograde approach is as effective and safe as the antegrade approach in the treatment of femoropopliteal CTO. It should be noted that it can be used as an alternative method without the need for any support device, especially in cases where the antegrade approach is unsuccessful.

Keywords: Retrograde access, endovascular, chronic total occlusions, TASC classification

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INTRODUCTION

Peripheral arterial disease (PAD) has been increasing worldwide, and it affects more than 200 million people worldwide and >30% of old patients [1,2]. Especially in patients with critical limb-threatening ischemia (CLI), it causes a major risk for amputation and death [3]. The endovascular approach continues to develop with new techniques and devices in the treatment of PAH. With the endovascular treatment model, it has been shown that there is a significant decrease in the number of amputations in patients with (CLI), a decrease in extremity pain and an increase in walking distance in patients with claudication [4-6]. However, in some lesions, technical success of the interventional treatment and the patency rates of the treated arteries are adversely affected. Especially long and calcific total occlusions are cases with high clinical difficulty [7]. The endovascular recanalization approach is frequently preferred in the treatment of CTO, especially in the femoropopliteal region, because it causes minimal trauma, has few post-procedure complications and is adopted as clinically effective [8]. In accordance with the trend European Society of Cardiology (ESC) guidelines on the treatment and diagnosis of PAD, an endovascular approximation is recommended first, even in patients with long (>25 cm), occlusive femoropopliteal lesions. [9]. In order to achieve satisfactory success, the operator must be experienced in various recanalization methods, inclusive antegrade and retrograde techniques to reduce surgery time and contrast agent dose, and to minimize complications. In approximately 20-25% of cases, even experienced operators in big centres may fail to treat long occlusive femoropopliteal lesions with an antegrade approximation, or re-entry apparatus may be required after subintimal passage associated with sequential multiple stent implantation [10-12]. In the long run, this results in excess costs and perhaps less open patency rates. For this reason, retrograde methods with a high achievement ratio (>90%) and low complication ratio have been recommended for the recanalization of long occlusive lesions [13,14].There are limited data comparing approaches to ante-retrograde recanalization in femoropopliteal lesions. In this study, ante-retrograde approaches of femoropopliteal lesions; procedural parameters such as duration of the procedure, number of stents placed, administration of contrast material, exposure to radiation and complications before and after the procedure were evaluated and compared. Hence, it was aimed to research the impacts of different approaches in endovascular treatments on extremity saving, patency of the arteries and mortality.

MATERIAL AND METHODS

This retrospective study was carried out between February 2019 and April 2022 in Tekirdağ Namık Kemal University Medical Faculty Hospital, Department of Cardiovascular Surgery after ethics committee approval was obtained in January 2019. A total of 437 patients who were diagnosed with chronic total occlusion in the femoropopliteal region and who subsequently underwent endovascular procedures in our clinic were included in the study and evaluated retrospectively. Patients were grouped as antegrade access and retrograde access. Our study was approved by the ethics committee of our hospital and was conducted in accordance with the Declaration of Helsinki. Initial, pre-procedure and post-procedure information of all patients were collected retrospectively from patient archives and from the examinations made by calling the patients for controls. All patients underwent radiological and clinical evaluations, Rutherford clinical classification, lower extremity arterial (LEA) ultrasonography, ankle-brachial index (ABI) or computed tomography angiography (CTA). For vascular disease, risk factors including smoking, hyperlipidemia, arterial hypertension, diabetes mellitus, and family history of CAD were listed. Patients who had previously undergone interventional or surgical operations, with chronic renal failure for PAH were excluded from the study. After the procedure, renal functions were evaluated and patients who developed renal failure were recorded. All patients were grouped according to the Rutherford and TASC II (Transatlantic Intersociety Consensus II) classification. The presence of claudication and CLI were evaluated in separate groups. Data were recorded by evaluating the type of treatment applied during the procedure (such as PTA, stent, atherectomy), patients who required additional treatment after dissection, patients who underwent retrograde intervention after unsuccessful antegrade access, complications during or after the procedure, and unsuccessful procedures.

Endovascular Procedures

Antegrade Approach

After 6F or 7 F sheaths were placed in the femoral arteries with USG guidance, all patients were given 5000 IU bolus heparin. After the process, the patients were loaded with ASA or clopidogrel according to the procedure. Depending on the condition of the occlusive lesion, retrograde puncture of the contralateral CFA followed by passage or antegrade puncture of the ipsilateral common femoral artery (CFA) was used for antegrade recanalization of femoropopliteal lesions. Failure to enter the occlusion from the proximal and failure to re-enter the true lumen after the subintimal transition were considered unsuccessful antegrade procedure. Straight and angled augmentation catheters, high penetrating guide wires, and re-entry devices were permitted in all cases and were used at the discretion of the responding physician.

Retrograde Approach

For distal access, a puncture was made from the popliteal artery or distal superficial femoral artery using 4 French radial sheaths (7 cm). In most of the cases, 0.035 hydrophilic wire and 100 cm support catheter with 4 French diameters were used. A re-entry

device was not used in any of the cases, and in all successful cases, the lesion was crossed with the help of a wire support catheter and balloon. A retrograde approximation was considered in the similar session in all situations in which anterograde wire crossover from the occlusive lesion was unsuccessful. In general, the lesioned area was first treated with standard balloon angioplasty for predilatation, followed by drug-coated balloon (DCB) angioplasty and, if necessary, stent placement. After DCB, follow-up was performed in linear and minor dissections that allowed flow and/or in the presence of 30% or less remaining stenosis after balloon angioplasty. In situations where there was a contrast substance passing through the lumen and/or a residual stenosis of 50% or more after balloon angioplasty, self-expanding stents (Nitinol Supera Stent, Abbott Vascular, Illinois, USA or Innova™ Vascular Self Expanding Stent System, Boston Scientific, Galway, Ireland) were placed to restrict the flow.

Angiographic Information

All cases were assessed in terms of vessel calcification and occlusion length. The degree of lesion calcification was classified according to the peripheral arterial calcium scoring system (PACSS). According to classification, 0 = no calcium image; 1 and 2 unilateral calcifications were categorized as <5 or ≥5 cm, and 3 and 4 bilateral calcifications as <5 or ≥5 cm [15,16]. Vessel diameters and occlusion length measurements were evaluated. The complexity of the lesion was determined by performing the TASC classification [17]. Data such as the total duration of the procedure, contrast material application, number and total length of stent and drug-coated balloons, radiation exposure and complications before and after the procedure were recorded.

Evaluation of the Procedure

The TIMI (thrombolysis in myocardial ischemia) classification was used to evaluate the distal blood flow from the lesion site [18]. Accordingly, TIMI 0 refers to no contrast transition distal to the stenosis (total occlusion), while TIMI 1 refers to small amount and weak contrast transition distal to the stenosis (subtotal occlusion). TIMI 2 is defined by the contrast agent that reaches the distal part of the vessel, and the filling rate decreases compared to other vessels that are not occluded. TIMI 3 is defined as the contrast agent reaching the distal of the vessel at the same time as other vessels that are not occluded.

Tracking Protocol

The puncture sites of all patients were examined with Doppler USG on the day after the process, and the presence of complications such as pseudoaneurysm and arteriovenous fistula was examined. At the 1st, 6th, 12th and 24th months after discharge, the patients were called for control and the target lesion patency was examined by arterial USG and/or lower extremity CTA when necessary. Re-intervention was planned when necessary in patients with recurrent ischemic symptoms or arterial restenosis. Restenosis or re-occlusion was noted. Restenosis during follow-up was determined as more than 50% luminal diameter loss in Doppler ultrasonography [19]. The openness was specified as <30% stenosis in the lesioned vessel. Technical achievement for all cases was defined as less than 30% residual stenosis in the relevant segment after the procedure. Above ankle amputation and >50% stenosis in the lesioned segment were considered a failure. ABI, improvement in limb salvage and clinical symptoms were evaluated in controls.

Statistical Analysis

Statistical data analysis of the study was performed using the Statistical Package for Social Sciences program version 11.0 (SPSS inc, Chicago, USA). Normally distributed continuous variables were presented as mean and standard deviation, non-normally distributed continuous variables were presented as median, and nominal variables were presented as numbers and percentages. While recording the data, mean±standard deviation (SD) was calculated as number and percentage. Pearson chi-square test was used when it was necessary to compare different variables. Independent t-test was used in the analysis of continuous variables between groups. The patients were followed regularly. At follow-up visits, lesion characteristics, restenosis rates, and amputation rates were analyzed and compared. A p value of <0.05 was noted statistically significant.

RESULTS

The antegrade approach was carried out in 218 of the endovascular procedures. Antegrade recanalization was successful in 201 patients (92.2%) and the antegrade attempt was a failure in 17 patients because the lesion could not be crossed. These patients were treated with retrograde access in the same session. Success was accomplished in 7 patients, but the procedure was terminated in 4 of the remaining 10 patients due to joint deformity and in 6 patients because the lesion could not be crossed. Successful results were obtained by surgical intervention in 10 patients. Successful recanalization was achieved in 185 of 197 patients who underwent intervention with the retrograde approach, and unsuccessful intervention was observed in 12 (93.9%) due to weak distal flow and stiffness of the lesion. Surgical operations were successfully performed on these patients. The demographic characteristics, and clinical and laboratory findings of the patients are grouped according to the entry slots and they are summarized in Table 1. While the average age was 67.9±7.6 years in the antegrade group, it was 68.4±6.6 years in the retrograde group. Considering the distribution of Rutherford clinical classification before the procedure according to the groups, there were 149 (74%) stage 3 patients in the antegrade group, and 136 patients (71%) in the retrograde group with stage 3. In Rutherford stage 3 patients, revascularization was applied to patients whose claudication complaints persisted despite maximal medical treatment. No statistically significant difference was found between the groups according to the Rutherford staging method.

Table 1. Demographic and clinical characteristics and laboratory markers

Variables n(%) mean±(SD)	Antegrade group (201 patients)	Retrograde total group (retrograde procedure after failed antegrade recanalization) (192 patients)	p
Age (years)	67.9±7.6	68.4±6.6	NS
Gender (male)	142(70.6)	137(71.3)	NS
Patients with claudication	155(77.1)	145(75.5)	NS
Patients with CLI	5(2.4)	5(2.6)	NS
Diabetes mellitus	90(45)	79(41)	NS
History of CAD	72(36)	77(40)	NS
Hypertension	115(60)	105(55)	NS
Smoking	150(75)	153(80)	NS
Hyperlipidemia	64(32)	78(41)	NS
Rutherford classification, n (%)			
Stage 2	20(10)	19(10)	NS
Stage 3	149(74)	136(71)	NS
Stage 4	22(11)	27(14)	NS
Stage 5	6(3)	6(3)	NS
Stage 6	4(2)	4(2)	NS
ABİ	0.49±0.16	0.43±0.12	NS
Hemoglobin (mg/dl)	12.8±2.2	12.3±1.9	NS
HbA1c (mg/dl)	6.4±2.1	6.1±1.9	NS

CLI critical limb ischemia, CAD coronary artery disease, NS non-significant, ABİ ankle-brachial index

Table 2 summarizes the information about the lesion characteristics. When the total occlusion lengths were examined, it was 13.8±7.1 cm in the antegrade group and 18.3±7.8 cm in the retrograde group, and there was a statistically significant difference between the two groups ($p<0.01$). When the PACSS scores were evaluated, no significant difference was found between the two groups. When the arteries affected by the occlusion were examined, 64.6% of the antegrade intervention group consisted of superficial femoral artery (SFA), 50% of the popliteal artery (PA) and 21% of the femoropopliteal artery occlusions. In the retrograde intervention group, 81.2% had SFA, 3.2% had PA, and 15.6% had femoropopliteal artery occlusions, and there was a statistically significant difference between the groups (Table 2). Data recorded during and after the procedure and early complications are summarized in Table 3. According to this table, 20 patients (9.9%) had >30% residual stenosis in the antegrade group, while 17 patients (8.8%) had >30% residual stenosis in the retrograde group. No important distinction was found between the groups. PTA was performed during the procedure in 20 patients with residual stenosis in the antegrade group. While primary patency was achieved in 15 patients, stent implantation and postdilatation were performed in 5 patients. PTA was performed during the procedure in 17 patients with residual stenosis in the retrograde group. While primary patency was achieved in 14 patients, patency was achieved by stent implantation and postdilatation in 3 patients.

Flow-limiting dissection was seen in 18 patients (8.9%) in the antegrade group and in 7 patients (3.6%) in the retrograde group and there was a significant difference between the two groups. In both groups, patients with flow-limiting dissection were implanted with a stent of suitable diameter and length so that patency was achieved. Considering the stent implantation rates between the two groups, it was seen in 40 patients (19.9%) in the antegrade group and in 19 patients (9.8%) in the retrograde group, which was a significant difference. Patients who underwent retrograde recanalization had a significantly lower number of stents than the antegrade approach (0.9±1.1 vs 1.9±1.3), which was statistically significant. Considering the total stent lengths, stent lengths were shorter in the retrograde group (6.4±8.1) compared to the antegrade group (12.8±9.7), and there was a significant difference between the two groups.

Table 2. Lesion characteristics

Variables n(%) mean±(SD	Antegrade group (201 patients)	Retrograde total group (retrograde procedure after failed antegrade recanalization) (192 patients)	p
Total occlusion length (cm)	13.8±7.1	18.3±7.8	<0.01
Calcification by PACSS score (cm)	2.21±0.91	2.25±0.96	NS
Affected artery n/%			
Süperfisyal femoral artery (SFA)	130 (64.6)	156 (81.2)	<0.01
Popliteal artery (PA)	50 (24.8)	6 (3.2)	<0.01
Femoropoliteal artery	21 (10.6)	30 (15.6)	<0.01
Distal reference diameter (mm)	5.2±0.5	4.2±0.6	<0.01
TASC classification n/%			
A lesions	10 (4.9)	8 (4.3)	
B lesions	21 (10.4)	19 (9.8)	
C lesions	158 (78.6)	150 (78.1)	
D lesions	12 (6.1)	15 (7.8)	

SFA superficial femoral artery, TASC Transatlantic Intersociety Consensus, NS non-significant, PACSS peripheral arterial calcium scoring system, NS non-significant

Table 3. Procedural data and peri- and postprocedural complications in patients who underwent ante- versus retrograde recanalization

Variables n(%) mean±(SD	Antegrade group (201 patients)	Retrograde total group (retrograde procedure after failed antegrade recanalization) (192 patients)	p
Residual stenosis>%30	20 (9.9)	17 (8.8)	NS
Flow-limiting dissection	18 (8.9)	7 (3.6)	<0.01
Stent placement	40 (19.9)	19 (9.8)	<0.01
DCB(cm)	18.2±16.0	28.5±12.0	<0.01
Number of stents	1.9±1.3	0.9±1.1	<0.01
Total stent length(cm)	12.8±9.7	6.4±8.1	<0.01
Distal embolization	2 (0.9)	2 (1)	NS
Pseudoaneurysm	3 (1.4)	2 (1)	NS
Contrast nephropathy	2 (0.9)	2 (1)	NS
Hematoma	4 (1.9)	1 (0.5)	NS
AV-fistula	0	0	N/A
Compartment syndrome	0	0	N/A
mTİMİ	2.7±0.2	2.8±0.3	NS
ABİ	0.76±0.14	0.78±0.12	NS
Procedure time (min)	42.5±16.1	30.7±14.4	<0.01
Fluoroscope time (min)	16.6±3.1	9.4±3.5	<0.01
Contrast volume (mL)	84.7±14.6	52.7±12.1	<0.01

DCB: drug coated balloons, mTIMI: modified thrombolysis in myocardial ischemia, ABI: ankle brachial index, AV-fistula: arteriovenous (AV) fistula, NS: non-significant

On the other hand, the use of drug-coated balloon (DCB) was less common in the antegrade group (18.2±16.0) compared to the retrograde group (28.5±12.0) and it was statistically significant. No life-threatening complications developed in any of the procedures. No significant difference was found when minor complications were compared in the antegrade and retrograde groups. 4 patients who developed distal embolisms were treated with thrombolytic infusion with the help of a thrombus aspiration catheter. While there was TIMI 0 flow in both groups in the control imaging performed before the procedure, the mean post-TIMI procedure was 2.8±0.3 in the retrograde group and 2.7±0.2 in the antegrade group. There was no significant difference between the groups in terms of post-procedure mTIMI values. When the mean ABI values were examined, although there was a significant increase in the groups, there was no statistically significant difference between the groups. Considering the duration of the procedure and the contrast material figures that are given, the mean procedure time was 30.7±14.4 minutes in the antegrade group, the average fluoroscopy time was 9.4±3.5 minutes, and the average contrast material amount was 52.7±12.1 ml. In the retrograde group, the average procedure time was 42.5±16.1 minutes, the mean fluoroscopy time was 16.6±3.1 minutes, and the mean contrast material amount was 84.7±14.6 ml. and there was a significant difference between the groups. Long-term results are summarized in Table 4. Accordingly, the primary patency rate was 92.2% (201/218), 85% (171/201), and 69.6% (140/201) in the antegrade group after angioplasty and at the following 12th and 24th-month controls, respectively. While there was no significant difference between the two groups in terms of the post-procedure and 1-year patency rates, a statistically significant difference was observed in the two-year follow-up. When the number of restenosis in one year was examined, it was 30 (14.9%) in the antegrade group and 26 (13.5%) in the retrograde group, and there was no significant difference between the groups. When the two-year restenosis numbers were examined, it was 61 (30.3%) in the antegrade group, while it was 49 (25.5%) in the retrograde group, which is a significant difference between the groups. When the one-year stent occlusions between the groups were examined, it was 14 (6.9%) in the antegrade group and 8 (4.1%) in the retrograde group, and there was a statistically significant difference between the groups. The two-year stent occlusion numbers were similar between the groups, but no significant difference was observed. Stent thrombosis was observed in four patients in both groups, and they were treated by balloon angioplasty. Total mortality rates were similar in both groups, and no significant difference was observed. Three patients (1.4%) in the antegrade group and 2 patients (1%) in the retrograde group underwent below-knee amputation after ischemic necrosis due to severely weak distal flows, large ulcerated lesions and diabetes.

Table 4. Long term results

Variables n(%) mean±(SD	Antegrade group (201 patients)	Retrograde total group (retrograde procedure after failed antegrade recanalization) (192 patients)	p
Primary patency rates			
1 year	171 (%85)	166 (%86.4)	NS
2 years	140 (%69.6)	143 (%74.4)	<0.05
Restenosis (>30% stenosis)			
1 year	30 (%14.9)	26 (%13.5)	NS
2 years	61 (%30.3)	49 (%25.5)	<0.05
Stent occlusion			
1 year	14 (%6.9)	8 (%4.1)	<0.05
2 years	18 (%8.9)	16 (%8.3)	NS
Stent thrombosis			
1 year	2 (%0.9)	2 (%1)	NS
2 years	0	0	NS
Mortality (total)	2 (%0.9)	2 (%1)	NS
Leg amputation	3 (1.4)	2 (1)	NS

NS: non-significant

DISCUSSION

Endovascular strategies are among the preferred options in the treatment of PAH, and in recent years, they can be considered as a treatment method even for femoropopliteal occlusive lesions of >25 cm in length [9]. Although surgical approaches have proven to be successful in providing blood flow to the distal parts of the ischemic extremity, endovascular methods are important options, especially in patients who are not suitable for surgery due to comorbidities such as CLI, diabetes mellitus, coronary artery disease, obstructive pulmonary disease, and cardiac insufficiency [17,20]. The aim of this study is to evaluate the efficacy of antegrade and retrograde recanalization approaches in patients with femoropopliteal CTO. In our study, one-year success rates of antegrade and retrograde recanalization were 85% and 86.4%, respectively, which were similar to the previously published studies [12,21-23]. However, in the two-year follow-up, the success rate was found to be higher in the retrograde group than in the antegrade group (69.6% and 74.4%). Similarly, when the rates of restenosis were examined, there was no significant difference between approaches in 1-year results, but retrograde recanalization strategy was observed to be more effective in two-year follow-ups ($p<0.05$). It has been reported that the probability of an angiographic dissection after balloon angioplasty in femoropopliteal lesions is between 50% and 84% [24,25]. The important thing here is whether the dissection is flow-limiting or not. In our study, flow-limiting dissection was observed at a rate of 8.9% in the antegrade intervention group and 3.6% in the retrograde intervention group. Long-term (approximately 3 minutes) percutaneous transluminal angioplasty (PTA) was attempted in these patients, and stent implantation was performed in resistant dissections. It is highlighted that long stent implantation, in other words, the full-metal jacket approach increases restenosis rates, a topic which has been emphasised in other studies in recent years [26,27]. However, more randomized controlled studies are needed to reach a definite conclusion on this matter. When the stent implantations used during the first procedure were evaluated in our study, it was noted that significantly fewer stents and shorter lengths were implanted in the retrograde intervention group ($p<0.01$). Despite technological advances in peripheral stents, in-stent restenosis and occlusion are still one of the most important problems in the long-term follow-up of endovascular stenting [28,29]. Since recanalization of the occluded stent is very difficult, the operational success of percutaneous re-intervention is low. In addition, complications such as perforation, subintimal access and slow flow are frequently observed during vascular re-intervention [30]. Endovascular stenting is seen as an alternative to surgical bypass grafting in patients with femoropopliteal segment lesions [31]. However, in-stent occlusion is a common complication of endovascular SFA stenting and the management of such conditions can be quite difficult [32]. In these patients, extremity-threatening recurrent ischemia and severe limping can be seen [33]. Therefore, they should be urgently revascularized to prevent extremity-threatening conditions. Therapeutic options in these cases are re-endovascular approach or surgical intervention. While endovascular interventions are less invasive, recanalization of an occluded stent is inconvenient as a consequence of neointimal hyperplasia and fibrosis [31]. For antegrade access, the guidewire is passed through the occluded SFA stent. Then, predilation with a balloon and stenting of the neolumen is performed [34,35]. It has been reported that the procedural success of revascularization of an occluded SFA stent in cases performed with the antegrade approach is only 13% to 26% [36]. Where an antegrade approach has failed, a retrograde transpopliteal approach may be considered as an alternative. Although there is a risk of vascular complications in the transpopliteal approach, it can save the extremity in cases where success cannot be achieved with the anterograde approach. The risk of amputation in the extremity is quite high in patients who cannot be revascularized in the antegrade or retrograde transpopliteal approach. In our study, stent occlusion was observed in a total of 18 (8.9%) patients in the antegrade intervention group, while stent occlusion was observed in a total of 16 (8.3%) patients in the retrograde intervention group. The results were in parallel with previous studies. When the stent occlusion rates were examined in one-year follow-up, there was no significant difference between the groups. Yet, it was observed that there were significantly fewer stent occlusions in the retrograde intervention group in two-year follow-ups. Acute stent thrombosis was seen in a total of 4 patients, 2 in the antegrade approach group and 2 in the retrograde approach group, in one-year follow-up. These patients were successfully treated with balloon angioplasty.

Another important issue in endovascular approaches is exposure to radiation, duration of the procedure and the amount of contrast material given to the patient. Although retrograde access is generally used as the second choice in endovascular approaches, in our study, when contrast agent administration, total radiation exposure and procedure time were compared between the groups, it was noted that the radiation exposure and the contrast material used were less in the retrograde approach group than the antegrade approach. The most common complications after endovascular procedures are distal embolism and dissection. In our study, distal embolism was observed in a total of 4 patients, 2 (0.9%) patients who underwent antegrade intervention after stent and PTA procedure and 2 (1%) patients who underwent retrograde intervention. In a study analysing perioperative complications, which was conducted with 2145 patients, the rate of distal embolization was found to be 1%. Similar rates were found in our study group [37]. In our study, successful results were obtained by applying tissue plasminogen activator (tPA) to four patients with distal embolism by placing a multi-hole catheter during the procedure.

CONCLUSION

The retrograde approach is as effective and safe as the antegrade approach in the treatment of femoropopliteal CTO. It should be noted that it can be used as an alternative method without the need for any support device, especially in cases where the antegrade approach is unsuccessful.

Ethics Committee Approval: This retrospective study was carried out between February 2019 and April 2022 in Tekirdağ Namık Kemal University Medical Faculty Hospital, Department of Cardiovascular Surgery after ethics committee approval was obtained in January 2019.

Patient Consent for Publication: A written informed consent was obtained from all patients.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: All authors contributed equally to the article.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

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