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Comparison of graft bypass surgery and endovascular interventional techniques in iliofemoral and above knee femoropopliteal arterial occlusion

İliofemoral ve femoropopliteal arterlerin tıkanıklığında endovasküler girişimler ile greft bypass cerrahisi tekniklerinin karşılaştırılması

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Abstract

Purpose: Peripheral vascular disease is associated with significant morbidity and mortality. In this study, we made a comparison between surgical bypass grafting and endovascular stenting in iliofemoral and above-knee femoropopliteal arterial occlusion to find out the advantages and disadvantages of each treatment method.

Matarials and methods: This is a retrospective study, where 60 patients had undergone endovascular and surgical interventions due to the occlusion of the iliofemoral and above-knee femoropopliteal arteries between January 2015 and December 2020. Patients were divided into two groups according to their treatment method. Group 1 contained 33 patients and was operated on with surgical bypass grafting, while group 2 contained 27 with endovascular intervention. Patients' morbidities, imaging methods, localization of occlusion, type of grafts and endovascular procedure, vascular patency, length of hospital stay, blood transfusion, revision, and complications were evaluated and analyzed.

Results: The femoral artery occlusion (72.7%) was in the majority in Group 1, while the iliac artery (66.7%) was in Group 2. There were three patients in Group 1 and 14 patients in Group 2 who had balloon administration. Regarding vascular patency, the grafts were occluded in 10 (45.5%) patients in Group 1, while stents were occluded in 12 patients (54.5%) in Group 2. Blood transfusion was performed in fifteen patients in Group 2 and six patients in Group 2.

Conclusion: The graft patency rate was higher in Group 1, and the re-revascularization rate of surgical treatment was lower than endovascular treatment. The highest graft patency rate was seen in the Dacron grafts then saphenous veins. Group 1 patients received more blood transfusions and extended hospital stayment periods than Group 2 patients.

Key words: Surgical bypass grafting, endovascular stenting, artery occlusion, vascular patency.

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Öz

Amaç: Periferik damar hastalığı önemli morbidite ve mortalite ile ilişkilidir. Bu çalışmada iliofemoral ve diz üstü femoropopliteal arter tıkanıklığında cerrahi baypas greftleme ile endovasküler stentleme arasında bir karşılaştırma yaparak her bir tedavi yönteminin avantaj ve dezavantajlarını ortaya çıkarmaya çalıştık.

Gereç ve yöntem: Ocak 2015 ile Aralık 2020 arasında 60 hasta bu çalışmaya retrospektif olarak dahil edildi. Hastalar tedavi yöntemlerine göre iki gruba ayrıldı. Grup 1 33 hastadan oluşuyordu ve cerrahi baypas greftleme ile ameliyat edildi, grup 2 ise endovasküler girişim ile 27 hastadan oluşuyordu. Hastaların morbiditeleri, görüntüleme yöntemleri, tıkanıklığın lokalizasyonu, greft tipi ve endovasküler işlem, damar açıklığı, hastanede kalış süresi, kan transfüzyonu, revizyon ve komplikasyonlar değerlendirildi ve analiz edildi.

Bulgular: Grup 1'de femoral arter tıkanıklığı (%72,7) çoğunluktayken, Grup 2'de iliak arter (%66,7) idi. Grup 1'de üç hasta, Grup 2'de balon uygulanan on dört hasta vardı. Vasküler açıklık açısından Grup 1'de 10 (%45,5) hastada greftler, Grup 2'de ise 12 (%54,5) hastada stent tıkandı. Grup 1'de on beş hastaya, Grup 2'de altı hastaya kan transfüzyonu yapıldı.

Sonuç: Grup 1'de greft açıklık oranı daha yüksek, cerrahi tedavinin yeniden revaskülarizasyon oranı endovasküler tedaviye göre daha düşüktü. En yüksek greft açıklık oranı, safen venlerden sonra Dakron greftlerde görüldü. Grup 1 hastalara Grup 2 hastalarından daha fazla kan transfüzyonu yapıldı ve hastanede kalış süreleri uzatıldı.

Anahtar kelimeler: Cerrahi bypass greftleme, endovasküler stentleme, arter tıkanıklığı, vasküler açıklık.

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Introduction

Peripheral arterial disease (PAD) is a chronic, lifestyle-limiting disease that results from arterial pathologies developing in the lower, upper extremities, intra-abdominal, carotid, and intracerebral branches. The prevalence of PAD, which usually develops based on atherosclerosis, increases with age. The prevalence increases up to 29% after 75, and just about 6% in the population aged 65-70. The risk of PAD increases in post-menopausal women due to the decreased protective estrogen hormone in elder females [1].

Most patients with PAD have no obvious symptoms. However, the prevalence of asymptomatic peripheral arterial disease is between 3-10%, and this rate rises to 15-20% at the age of 70 and above (35). In asymptomatic PAD's, death is 4%, and the risk of developing claudication in the future is 7-15% [2, 3].

Treatment options are conservative, medical, and revascularization. Revascularization options are surgical, endovascular, or hybrid procedures that apply both methods [4]. With the developing technology in recent years, the choice of endovascular treatment is rapidly increasing. Mortality and morbidity rates are lower than surgery, and many centers prefer endovascular intervention in the first place and resort to surgical treatment in case of failure. Anatomically, the size and location of the lesion, comorbidities, and experience effectively select endovascular or surgical treatment.

According to the stent types, the most commonly used stents are self-expandable nitinol stents and balloon-expandable stainless steel stents. Some studies have shown that self-expandable stents work better in the long run, but this theory is still unclear [5]. In isolated short and proximal lesions, stenting should be preferred in the first place. The length of the stenosis in the iliac artery should be less than 5 cm. The procedure's success rate has been reported as 90%, with patency rates of 80% for one year and 60% for five years. However, especially in the infrapopliteal region, endovascular treatment's success and patency rates are low. Therefore, it is not recommended except for particular indications [5].

In iliofemoral lesions, endovascular treatment to the femoral artery and surgical treatment to the iliac artery can be applied simultaneously [6]. Aorto-biiliac or aorto-bifemoral bypass surgery is usually performed for aortoiliac lesions. The surgical strategy may vary depending on the localization of the lesion, technical possibilities, and the patient's condition. Aortofemoral or aortoiliac bypass is more successful than other bypasses and has lower complication rates. Ten-year primary patency rates for aortobifemoral bypass range from 80% to 90% [7].

In the guideline published by the ESC in 2017, it was reported with the TASC II Class I indicated that the primary preference was endovascular treatment for isolated occlusive lesions at the aortoiliac level below 5 cm, surgical treatment should be considered for longer occlusive lesions [8]. Hybrid Procedures Treatments in which surgical treatment is used together with endovascular techniques are hybrid treatment. Hybrid procedures provide patients with multivessel disease the opportunity for simultaneous endovascular intervention and surgical reconstruction. Historically, hybrid therapy for the vascular disease was first reported in 1973 as a combination of iliac angioplasty and femoro-femoral bypass [9].

In this study, we aimed to study and analyze our center's results in managing iliofemoral and above knee femoropopliteal arterial occlusion. But, deciding which surgical technique is better was always the question. So, we collected the data of all the patients treated for such vascular pathology, and we included only the patients with whom we could connect.

Matherials and methods

This is a retrospective study, where 60 patients had undergone endovascular and surgical interventions due to the occlusion of the iliofemoral and above-knee femoropopliteal arteries between January 2015 and December 2020. In addition, mortality and morbidity were re-evaluated by calling the patients by phone. Ethics Committee Approval was taken, and all the patients we connected with signed the consent form.

Inclusion criteria for the patients included; Patients who previously underwent endovascular or surgical intervention or both of them for occlusion or stenosis of the iliac or above-knee femoropopliteal arteries. Only the patients who had ischemic pain, ischemic

ulcers, risk of losing extremity and whose life quality was affected negatively by this disease underwent operation (TASCII C or D).

Thirty-seven patients who could not cooperate or did not want or could not come to the control were not included in the study. A total of 60 patients were examined in two groups; Group 1: Patients who underwent surgical grafting (n=33), and group 2; Patients who underwent endovascular treatment with stent implantation (n=27). The decision on the type of treatment depended on several factors. The patient's general condition and age, the type of the lesion, the extension of the primary lesion, the kidney function tests of the patient, and the surgeon's preference with the result of the doctor-patient discussion were the main factors brought into attention while deciding on treatment method.

All patients' surgical notes pre-and post-procedure records were reviewed. In addition, the type of graft used in the surgery, the presence of stent/balloon, revision status, the level of the lesion, and the degree of obstruction were evaluated.

Follow-up period, mortality/morbidity, and patency of the vessel undergoing the vascular procedure were recorded as a result of the noninvasive evaluation (doppler, contrast-enhanced CT angiography, or contrast-enhanced MRI) and invasive (angiography) examinations.

Smoking and alcohol history, diabetes Mellitus (DM), hypertension (HT), hyperlipidemia (HL), history of coronary artery disease (CAD) and pre-op hemoglobin (HGB), pre-op White blood cell (WBC), pre-and post-op creatinine (CR) were evaluated too. In addition, medication, follow-up period, and length of hospital stay were recorded and analyzed.

Surgical Technique: Open surgical grafting (Group 1): After painting and draping, the femoral region is opened longitudinally, and gentle dissection is done to reach common femoral, superficial, and deep femoral arteries, which are wholly freed and rounded by vessel loops. A lower quadrant incision is made in an oblique shape of about 12-15 cm. Attention is taken not to enter the peritoneum, and extraperitoneal exposure to the iliac artery is achieved with the aid of retractors.

Before heparinization, graft tunneling is achieved by gentle finger dissection from the retroperitoneum to the femoral artery. The graft is passed through the tunnel under the inguinal ligament. Then heparin is given at the dose of 1mg/kg to keep activating clotting time (ACT) up to 250-350 seconds. First, proximal anastomosis (end-to-side) is achieved usually by using 4/0 polypropylene sutures. Then the distal anastomosis (end-to-side) is done by 5/0 polypropylene after de-airing the graft. Finally, hemostasis control is done, and a hemovac drain is inserted. Then, the incision is closed in the traditional fashion.

Endovascular balloon and stenting technique (Group 2): All our endovascular procedures are performed in the angiography department. After painting and draping, arteriography is performed via an ipsilateral or contralateral femoral approach. A 7F or 8F sheath is placed, and an angiogram is achieved using a contrast medium. After giving heparin at the dose of 1mg/kg to achieve ACT up to 250-350 seconds, a balloon-expandable stent is applied preferentially for focal lesions according to the lesion site, length, and nature. A control angiogram is taken before ending the procedure.

The anticoagulation protocol for patients in Group 1 and 2: In group 1: We gave low molecular Heparin anticoagulant ± antiplatelets (acetylsalicylic acid (ASA)) according to the patient's comorbidities and blood tests (mainly CBC). Pre-discharge, we shifted low molecular Heparin to oral anticoagulants (such as rivaroxaban, dabigatran, or apixaban)± ASA for two months at least. Then according to the patient's risk factors, we continued on those drugs or kept only ASA.

In group 2: Immediately after the procedure, we started clopidogrel ± ASA for at least six months. Then, according to the patient's risk factors and comorbidities, we continue those drugs or just ASA.

Statistical analysis

IBM SPSS Statistics 25 Windows Multilingual Assembly Editions program was used for analysis. Continuous variables are given as mean ± standard deviation and categorical variables as numbers and percentages. One-way analysis of variance compared independent group differences when

parametric test assumptions are met; When parametric test assumptions were not met, Kruskal Wallis Analysis of Variance was used to compare independent group differences. Repeated Measures Analysis of Variance was used for independent group comparisons when parametric test assumptions are provided; Friedman test was used when parametric test assumptions were not met. The differences between the categorical variables were analyzed by Chi-square analysis. In addition, the relationships between continuous variables were analyzed with Spearman or Pearson correlation analyzes.

This study was approved by Pamukkale University Clinical Research Ethics Committee.

Results

The mean age of the patients was 62.85 in the patient group who underwent a surgical procedure (Group 1) and 61.63 years in the patient group who underwent stenting with the endovascular procedure (Group 2). There was no statistically significant difference between the groups regarding age difference (p=0.663). When the genders of the patients were examined, 28 males and five females were in Group 1, while there were 24 men and three women in Group 2. Men were the majority in both groups, but statistically, there was no significant difference (p=0.108). On admission, 17 patients (51.5%) presented with acute status in Group 2, and 16 patients (48.5%) had chronic disease history. In Group 2, 15 (55.6%) were acute, while 12 (44.4%) were chronic. Statistically, there was no significant difference (p=0.480). When the operation site was examined, the femoral artery (72.7%) was in the majority in Group 1, while the iliac artery (66.7%) was in Group 2. In Group 1, 7 (100%) of 7 patients had iliac bypass grafts, and 17 (70%) of 24 patients whose femoral localization was involved and grafted were found to be open. In Group 2, the grafts were open in 6 (33%) of 18 patients with iliac artery stents and 1 (33%) of the three patients whose femoral localization was involved and stented.

While hypertension (HT) was nine patients in Group 2 (33.3%), it was 22 patients (68.8%) in Group 1, and there was a statistically significant difference (p=0.007). However, no statistically significant difference was found between the groups in terms of Diabetes Mellitus (DM), hyperlipidemia (HL), coronary artery disease (CAD), COPD, smoking history, and alcohol history (p<0.050) (Table 1).

Imaging methods and treatment procedures are given in Table 2. Accordingly, while the patients who underwent stent were three patients (9.1%) in group 1, they were 27 (100%) in group 2, a statistically significant difference was found between the groups (p=0.000).

There were three (9.1%) patients in group 1 and 14 (51.9%) patients in group 2 who had balloon administration, with a statistically significant difference between groups (p=0.000). When the vascular patency of the patients was examined, the grafts were occluded in 10 (45.5%) patients in group 1, while Stents were occluded in 12 patients (54.5%) in Group 2. There was no statistically significant difference between the groups (p=0.194).

Surgery was performed on all patients (100%) in group 1, and there were ten patients (37%) in group 2 who underwent surgery after angiography. A statistically significant difference was found between the groups (p=0.000).

The number of patients who underwent revision surgery was seven (21.2%) in Group 1 and ten patients (37%) in Group 2. There was no statistically significant difference between the groups (p=0.143).

CT angiography was used as the imaging method in 17 (53.1%) patients in Group 1, Doppler was used in 14 (43.8%), and MRI in 1 (3.1%), while CT angiography was used in 21 (84%) patients, Doppler was used in 3 (12%) and MRI in 1 (4%) patients in Group 2. A statistically significant difference was found between the groups regarding imaging methods (p=0.034) (Table 2).

According to the graft types which were used in Group 1, a saphenous vein graft was applied to 6 (18.2%) patients, Dacron tube grafts were applied to 18 (54.5%), and PTFE ring grafts were applied to 9 (27.3%) patients. Saphenous vein graft was applied to 2 (20%) patients, Dacron tube grafts were applied to 5 (50%), and PTFE ring grafts were applied to 3 (30%) patients in Group 2, where endovascular intervention was not enough or stents found occluded. There was no statistically significant difference between the two groups (p>0.050) (Table 2).

Table 1. Demographic Data of the Patient Groups, co-morbidities with involvement arteries and post-procedure patency rate

		Group 1 (n=33)		Group 2 (n=27)	
		Mean±S.S.	Med (min-max)	Mean±S.S	Med (min-max)	***p***
Age		62.85±11.51	65 (34-83)	61.63±9.63	63 (47-75)	0.663
Gender	**Female**	5 (15.2 %)		3 (11.1%)		0.474
	Male	28 (84.8%)		24 (88.9%)		
Co-Morbidities	**DM**	16 (50%)		11 (40.7%)		0.327
	HT	22 (68.8%)		9 (33.3%)		0.007
	HL	9 (28.1%)		6 (22.2%)		0.415
	CAD	12 (37.5%)		7 (25.9%)		0.253
	COPD	5 (15.6%)		3 (11.1%)		0.455
	Smoking	20 (62.5%)		19 (70.4%)		0.360
	Alcohol	5 (15.6%)		3 (11.1%)		0.455
Presentation status	**Acute**	17 (51.5%)		15 (55.6%)		0.480
	Chronic	16 (48.5%)		12 (44.4%)		
Location of obstruction		**Group 1 (n=33) %**		**Group 2 (n=27) %**		
Iliac		7 (21.2%)		18 (66.7%)		
Femoral		24 (72.7%)		3 (11.1%)		
Popliteal		0 (0%)		2 (7.4%)		
Femoral+popliteal		0 (0%)		1 (3.7%)		
Iliac+femoral		2 (6.1%)		2 (7.4%)		
Iliac+femoral+popliteal		0 (0%)		1 (3.7%)		
Patency						
	location	**grafting**		**stenting**		
	Iliac	7 (100%)		6 (33%)		
	Femoral	17 (70%)		1 (33%)		
	Popliteal	0		0		
	Femoral+popliteal	0		0		
	Iliac+femoral	2 (100%)		2 (100%)		
	Iliac+femoral+popliteal	0		0		

DM: Diabetes mellitus, HT: Hypertension, HL: Hyperlipidemia, CAD: Coronary artery disease, COPD: Chronic obstructive pulmonary disease

Table 2. Types of surgical procedures, imaging methods, and graft types performed on patients in Group I and Group II

		Group 1 (n=33) n (%)	Group 2 (n=27) n (%)	*p*
Types of procedure				
Stent	No	30 (90.9%)	0 (0%)	0.000
	Yes	3 (9.1%)	27 (100%)	
Balloon	No	30 (90.9%)	13 (48.1%)	0.000
	Yes	3 (9.1%)	14 (51.9%)	
Patency	No	10 (45.5%)	12 (54.5%)	0.194
	Yes	23 (60.5%)	15 (39.5%)	
Surgery	No	0 (0%)	17 (63%)	0.000
	Yes	33 (100%)	10 (37%)	
Revision	No	26 (78.8%)	17 (63%)	0.143
	Yes	7 (21.2%)	10 (37%)	
Imaging Method	CT-Angiogram	17 (53.1%)	21 (84%)	0.034
	Doppler USG	14 (43.8%)	3 (12%)	
	MRI	1 (3.1%)	1 (4%)	
Types of Grafts for group 1 and for the Revision of group 2				
Saphenous vein graft		6 (18.2%)	2 (20%)	0.935
Dacron tube graft		18 (54.5%)	5 (50%)	
PTFE ring graft		9 (27.3%)	3 (30%)	

All the patients who underwent revision were evaluated; in Group 1, four patients underwent graft embolectomy, one patient had hematoma evacuation, one had abdominal exploration, one had an endovascular intervention, and one had been revised for bleeding control. In Group 2, ten patients were referred to open surgery, and revision surgery was performed with graft bypass (Table 3).

In Group 1, four (12.1%) patients had extremities amputation. In contrast, amputation was performed in Group 2 in one (3.7%) patient. There was no statistically significant difference between the two groups (p=0.246).

Blood transfusion was performed in 15 (46.9%) patients in Group 1 and six (23.1%) in Group 2. No difference was found between the two groups (p>0.050). In Group 1, two patients (6.1%) died, whereas 31 (93.9%) survived. In Group 2, six (22.2%) patients died, and 21 (77.8%) survived. No difference was found between the two groups regarding mortality (p>0.050). Mortality causes varied from untreated CAD in one patient and untreated severe mitral insufficiency and heart failure in the other patient in Group 1, to one CVA, one multiple organ failure, two heart failure, and two pulmonary diseases in Group 2 (Table 3). The hospitalization and follow-up periods were calculated for all the patients. the average hospital stay was 11.33 days in Group 1 and 6.15 days in Group 2. There was no statistically significant difference (p>0.050). Follow-up time in months was calculated too and found to be 30.77 in Group 1 and 20.87 months in Group 2. There was no significant difference, too (p=0.186). The patients' mean preoperative creatinine (Cr) was 1.76 in Group 1, and 1.18 in Group 2. The postoperative creatinine

was 1.89 on average in group 1 and 1.59 on average in group 2. There was no statistically significant difference between the two groups (p=0.064) (p=0.534), respectively. Also, there were no significant differences between groups regarding preop HGB and preop WBC. When the postoperative complications were examined (100-200 meters) claudication was observed in 10 patients in Group 1. In addition, one patient had a foot wound, one patient was immobile, and one patient had a chronic renal failure (CRF) accompanying claudication. There were no complications in the other 20 patients who underwent surgery.

Comparison of vessel patency with radiological and post-procedural findings is given in (Table 4). There was no statistically significant difference between vascular patency and imaging method, presence of revision, and mortality rates (p>0.050). Vascular patency was found in 6 patients with saphenous vein grafts, while it was occluded in two patients. In Dacron grafts, the graft was occluded in five patients compared to 18 patients with normal vascular patency. Four grafts were patent in PTFE ring grafts, while the number of occluded grafts was 8. A statistically significant difference was found between graft patency and graft type (p=0.024) (Table 4).

Table 3. Types of revision surgery and postoperative blood transfusion, mortality and amputation rates

Types of revision surgery	**Group 1 (n=7)**	**Group 2 (n=10)**	
Graft bypass	0	10	
Graft embolectomy	4	0	
Hematoma evacuation	1	0	
Abdominal exploration for bleeding control	1	0	
Endovascular intervention	1	0	
Postoperative blood transfusion, mortality and amputation rates			
	Group 1 (n=33) %	**Group 2 (n=27) %**	***p***
Blood transfusion	15 (46.9%)	6 (23.1%)	
Exitus	3 (13.6%)	5 (13.2%)	0.073
Amputation	4 (12.1%)	1 (3.7%)	

Table 4. Comparison of vessel patency with radiological and post-procedural findings

		Occluded (n=22) %	**Patent (n=38) %**	***p***
Imaging Method	CT angiography	16 (72.7%)	24 (63.2%)	
	USG Doppler	5 (22.7%)	13 (34.2%)	0.620
	MRI	1 (4.5%)	1 (2.6%)	
Graft Type	Saphenous vein graft	2 (25%)	6 (75%)	
	Dacron tube graft	5 (21.73%)	18 (78.26%)	0.024
	PTFE ring graft	8 (66.6%)	4 (33.3%)	
Revision	No	14 (63.6%)	29 (76.3%)	0.224
	Yes	8 (36.4%)	9 (23,7%)	
Mortality	Exitus	3 (13.6%)	5 (13.2%)	0.623
	Survivor	19 (86.4%)	33 (86.8%)	

Discussion

Peripheral vascular disease is associated with significant morbidity and mortality. In terms of vascular patency, the graft patency rate was higher in the surgical group than in the endovascular group. The other advantages and disadvantages of each treatment method for iliofemoral and above-knee femoropopliteal arterial occlusion had been studied and analyzed in this study.

There is a dramatic increase in the prevalence of PAD with advanced age [10, 11]. In a similar study conducted in 2005, 244 patients were examined; The mean age of the patients who underwent endovascular intervention has been reported as 67 and 66 in those who had bypass surgery. In the same study, men were found to be the majority in endovascular treatment with 62.6% and surgery with 75.2% [11].

In our study, men were higher than the rates in the literature; It was the majority with 24 patients (88.9%) who underwent endovascular surgery and 28 patients (84.8%) who underwent surgery. Habits like smoking, irregular diet, and doing little exercise are common in men's lifestyle in our country, which is possible for this higher rate.

Patients who had presented with acute symptoms and underwent immediate surgery were about 51.5%, while 48.5% had chronic symptoms. Endovascular interventions were performed in 55.6% who had acute admission and 44.4% of patients with chronic symptoms.

Hypertension (HT) is a significant risk factor for peripheral arterial diseases. In a study done in 2014, HT was found relatively high in patients who had undergone endovascular intervention (77%) and surgery in the lower extremities (77.82%), respectively [12]. In another study with the same criteria, HT was reported in the range of 75-92% [13]. In our study, there were nine patients (33.3%) diagnosed with HT in the endovascular intervention group and 22 patients (68.8%) in the surgery group. Compared to the literature, the rate of HT in peripheral arterial patients was lower in our study. Although there was a statistically significant difference between the groups in our study, we did not consider the HT risk factor as a determining factor when choosing surgery or endovascular intervention in clinical application.

Hyperlipidemia (HL) is considered a significant risk factor in cardiovascular diseases. Malas et al. [12] reported the rate of HL as 82% in patients treated with angiography and 74% in patients treated with surgical treatment. According to our study, there were nine patients (28.1%) in the surgical group, and six patients (22.2%) in endovascular interventions who had hyperlipidemia; this rate was lower than in the literature, we did not accept it as a determining factor among the patients who underwent endovascular/surgical treatment since there was no significant difference between the groups.

In our study, the most frequently involved location in peripheral artery patients who underwent surgery was the femoral artery (72.7%), followed by the iliac artery. However, in our patients who underwent endovascular treatment, the most common site of involvement was the iliac artery, with a rate of 66.7%. Catheter-based procedures in patients undergoing endovascular intervention with stenting have been used more widely in recent years than the surgical approach in the lower extremities. An important indicator is the length and grade of the lesion detected during the clinical presentation of patients who are planned to be treated with stent or balloon angioplasty [14].

In a study done in 2009, the 24-month patency rate in stented patients was 75% and 81% in bypass grafting; thus, results in favor of surgery have been reported [15]. However, in another study conducted in 2010, it was reported that there was no significant difference in patency rates between stenting and bypass surgery [16].

Malas et al. [12] reported that 88% of patients who underwent angioplasty were stented. After a 24-month, the patency rate of patients with stent was reported as 67%, while it was 75% in patients with surgical bypass grafting. Our study observed that three (9.1%) of 33 patients who underwent surgery had a history of stenting. In the control imaging of two of these patients, intrastent vascular patency was not preserved. Stents were placed in 27 patients (100%) who underwent endovascular intervention. We found that stent patency was preserved in fifteen (39.5%) of these patients. Our stent patency rate in patients who underwent endovascular intervention was slightly lower than in the

literature. This low patency rate may be due to the irregularity of patients in the use of blood thinner drugs. On the other hand, the patency rate (60.5%) in our patients who underwent surgery was in line with the literature and was superior to endovascular intervention.

In addition, when we evaluated the localization and graft patency in Group 1, we found that seven of seven patients (100%), who had iliac localization, had patent iliac grafts, and 17 of 24 patients (70%) with femoral localization had femoral patent grafts. In Group 2, the grafts were patent in 6 (33%) of 18 patients with iliac stents and 1 (33%) of the three patients with femoral stents. As a result, it was observed that grafting was superior to the stent in all localizations.

In a study of patients who underwent surgery with endovascular intervention, the grafts' patency rates gave better results after two years of follow-up. However, the failure rate of angioplasty was 25% higher. In addition, the revision rate was found to be significantly higher than in surgery [16].

The most crucial complaint in endovascular interventions and surgery is claudication. Surowiec et al. [10] reported 32% of patients with moderate to mild limping and 32% of patients with severe fatigue and limping. In the same study, the rate of patients with 200 meters claudication was reported as 49% in patients who underwent dacron-PTFE grafting and 32% in patients who underwent saphenous vein grafting. The rate of claudication above 100 meters in patients who underwent stenting was 66%. Karch et al. [17] reported 60% complications in stented angiography. The majority (75%) of complications included fatigue and severe pain when walking. When the patients in our study were examined, five patients in Group 1 experienced claudication at 100 meters, two patients at 150 meters. In Group 2, three patients experienced claudication above 200 meters. In addition, foot wounds in Group 1 and in Group 2 chronic renal failure and immobilization were seen in one patient.

Short-term postoperative complications in lower extremity surgery may include acute renal failure, arterial injury, acute MI, arrhythmia, and congestive heart failure [16, 18]. Also, post-surgical dissection, bleeding, occlusion, infection need to be revised. In revision, various operations such as embolectomy, hematoma evacuation, bleeding control, bypass, and endovascular intervention (atherectomy, drug-coated balloon angioplasty, stenting) may be required [18].

Krankenberg et al. [11], in their studies with stent versus surgery in the femoral-popliteal location, reported revisions for reasons such as dissection, hematoma evacuation, thromboembolic, aneurysm, and arteriovenous fistula. In addition, Karch et al. [17] observed hematoma in five patients in the study group whose 4-year long-term results were examined.

Our study achieved re-revascularization by embolectomy in four of seven patients who underwent surgical revision, abdominal exploration for bleeding control in one and endovascular intervention was performed in another patient. The revision numbers in our study were similar to the literature.

Digital Subtraction Angiography (DSA) was the primary way of evaluating peripheral arterial disease and is considered the gold standard compared to other methods. However, (DSA) may be insufficient to visualize the distal vascular bed in patients with proximal lesions. In contrast, Doppler USG imaging allows both functional and anatomical evaluation. Therefore, this non-invasive imaging method can be considered one of the best preoperative radiological methods, especially in patients with contrast material allergy or renal failure [19].

A study done by Katsamouris et al. [20] detected 12 open tibial arteries with Doppler in 10 extremities that angiography could not demonstrate. Doppler examination of the above-knee popliteal artery gave a significantly correct diagnosis in all four extremities, but arteriography gave false results.

Catalano et al. [21] compared the infrarenal aorta and lower extremity arteries with CT Angiography and DSA in 50 patients with peripheral artery disease. They found the sensitivity 96%, specificity 93%, and accuracy 94%. With the development of multidetector CT technology, CT Angiography has replaced DSA in most cases. In the last ten years, many surgeons have preferred CT Angiography to DSA, which is less invasive and cheaper than DSA. It allows three-dimensional imaging and

contains less radiation than DSA too. While CT Angiography provides anatomical evaluation, Doppler US provides additional functional evaluation. On the other hand, CT Angiography does not reflect the hemodynamic results of the lesion and may not be sufficient alone for diagnosis because only the vascular lumen is shown. Therefore, the correlation of CT Angiography with Doppler USG is considered the most accurate approach [22].

In our study, 17 patients were operated on with endovascular intervention, and 21 patients with surgery underwent control imaging with CT angiography. Thrombosis was seen in 16 patients, and vascular patency was normal in 24 patients. However, one of the two patients checked with MRI had occlusion. Creatinine level may affect the choice of imaging methods. In patients with high creatinine levels, Doppler USG is preferred. However, since it is impossible to evaluate clearly with Doppler in some localizations, MRI is preferred in the second plan, and CT angiography is preferred as the last resort. Here, 17 patients were visualized with Doppler, and thrombosed veins were seen in 5 patients. Since different imaging methods were not applied to the same patients, we correctly accepted the Doppler imaging results. A comparison of imaging methods was not made, and it was used as a tool to evaluate graft patency. If the patient's creatinine level was appropriate (creatinine <1.5), it was seen that the most preferred imaging method was CT Angiography. The rate of using CT angiography is higher in patients undergoing endovascular intervention than in surgical patients. Contrast-induced nephropathy is not a concern, as the creatinine levels of patients likely to be treated with endovascular intervention are low.

Autogenous saphenous vein graft is preferred for bypass grafting for its' long-term patency rates in lower extremity ischemia since the patient has autogenous tissue [23]. In addition, dacron tube graft and PTFE ring grafts have become widespread in recent years.

In our study, 12 patients with PTFE grafts had thrombosis (66.6%), while two patients from eight patients with saphenous vein grafts (25%) and 23 patients with dacron grafts had thrombosis at a rate of 21.26%; thus, the type of the graft with the highest patency rate was the dacron graft. However, saphenous vein grafting requires long incisions in the lower extremity. In a study conducted for the femoral-popliteal region in which autogenous saphenous vein graft was used, the 5-year primary patency rate was reported as 70-80% [24]. Our results show parallelism with the literature.

The literature shows that the average length of hospital stay is five days after endovascular intervention and 11 days after surgery. After 30 days, the need for revision is 6% [18]. In our study, the mean hospital stay time for patients who underwent surgery was 11.33 days and the mean follow-up period was 30 months. The mean hospital stay time was 6.15 days, and the mean follow-up time was 20.9 months in patients who underwent endovascular intervention. Our study's length of hospital stay in both endovascular intervention and surgery was consistent with the literature.

The main limitation of this study: We anticipate that comparing our short to mid-term results with the long-term results will yield more accurate results as it becomes possible to renew it with more patients. Since angioplasty is frequently preferred in the iliac region, data on patients undergoing surgery are limited. In future studies, we need to focus on the results of surgical treatment for lesions in the iliac region with a more extensive population.

As a result, in terms of vascular patency, the graft patency rate was 60.5% in patients who underwent surgical treatment, while the stent patency rate was 39.5% in patients who underwent endovascular treatment. Therefore, the success rate of surgical treatment is higher. On the other hand, re-revascularization rates of surgical treatment are lower than endovascular treatment. The graft type with the highest patency rate was seen in the dacron grafts. The saphenous vein is the second most common, while the PTFE ring graft is the third. Patients undergoing surgical treatment received more blood transfusions than patients receiving endovascular treatment. In addition, the hospitalization and follow-up period of the patients in Group 1 is more extended than the Group 2 patients. Mortality rates were higher in Group 2 patients than the patients in Group 1. Considering patient comfort and early mobilization, we suggest that angiography

should be considered the primary choice in the lower extremity, especially in the iliac region, which is challenging to operate in surgery.

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Authors' contributions

M.B. designed the study, data collection, literature search, manuscript writing, and final approval of the version to be published. M.A. and M.C.C. drafted the manuscript, designed with the co-writer, and verified the analytical methods and final approval of the version to be published.