Analysis of risk factors for occlusions of a synthetic femoropopliteal bypass graft

Analiza faktora rizika od okluzije sintetskog grafta kod femoropoplitealnog bajpasa

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Abstract

Background/Aim. Femoropopliteal bypass is a revascularization technique of lower extremities with excellent outcome. The great saphenous vein is the best graft material, but if it is not adequate or has been removed, synthetic grafts are an useful alternative. Graft occlusion is the most significant complication with the most serious consequences. The aim of this study was to analyse predictive factors for the synthetic femoropopliteal bypass occlusions. **Methods.** This retrospective case-control study included all patients who underwent synthetic femoropopliteal bypass due to peripheral arterial occlusive disease at the Vascular Surgery Center, Clinical Center of Kragujevac, Serbia, from 2007 to 2013. The cases group were the patients with femoropopliteal graft occlusion (n = 44), with the control group consisted of the patients without such an outcome (n = 88). **Results.** Significant effects to occlusion were: concomitant cardiovascular disease ($_{adjusted}$OR 27.05; 95% CI 4.74; 154.35), a type of femoropopliteal bypass ($_{adjusted}$OR 16.50; 95% CI 4.05; 67.24), previous vascular intervention ($_{adjusted}$OR 4.67; 95% CI 1.20; 18.14), clinical stage of the disease ($_{adjusted}$OR 3.73; 95% CI 1.94; 7.18), administration of postoperative oral anticoagulant therapy ($_{adjusted}$OR 0.05; 95% CI 0.01; 0.23) and the use of angiotensin converting enzyme inhibitors ($_{adjusted}$OR 0.14; 95% CI 0.03; 0.70). A significant synergism was shown for the following combinations of the observed risk factors: type of femoropopliteal bypass and cardiovascular disease, type of femoropopliteal bypass and previous vascular intervention, previous vascular intervention and cardiovascular disease, previous vascular intervention and beta blockers, cardiovascular disease and diabetes, type of femoropopliteal bypass and antiaggregant therapy, clinical stage of disease and cardiovascular disease, previous vascular intervention and antiaggregant therapy. **Conclusion.** Concomitant cardiovascular disease, below-knee femoropopliteal bypass, advanced stage of vascular disease and non-use of anticoagulant therapy and angiotensin-converting enzyme inhibitors are the significant predictors of graft occlusion after synthetic femoropopliteal bypass. Their synergistic effect determines the importance of diabetes, use of beta blockers and platelet antiaggregant therapy.

Key words:
graft occlusion, vascular; biocompatible materials; femoral artery; saphenous vein; risk factors.

Apstrakt

Uvod/Cilj. Femoropoplitealni (FP) bajpas je revaskularizaciona tehnika donjih ekstremiteta sa odličnim ishodom. Velika vena safena najbolji je materijal za graft, ali ako nije adekvatna ili je uklonjena, sintetički graftovi su korisna alternativa. Najznačajnija komplikacija sa ozbiljnijim posledicama je okluzija grafta. Cilj rada bio je da se analiziraju faktori za okluziju sintetičkog grafta kod FP bajpasa. **Metode.** Ova retrospektivna studija tipa slučaj-kontrola obuhvatila je sve bolesnike kod kojih je urađen FP bajpas sintetskim graftom zbog arterijske bolesti donjih ekstremiteta u Centru za vaskularnu hirurgiju Kliničkog centra u Kragujevcu od 2007. do 2013. godine. Grupu slučajeva činili su bolesnici sa okluzijom femoropoplitealnog bajpasa (n = 44), a kontrolnu grupu činili su bolesnici bez takvog ishoda (n = 88). **Rezultati.** Značajan uticaj na okluziju imali su prateća kardiovaskularna oboljenja ($_{adjusted}$OR 27,05; 95% CI 4,74; 154,35), vrsta femoropoplitealnog bajpasa ($_{adjusted}$OR 16,50; 95% CI 4,05; 67,24), prethodna vaskularna intervencija ($_{adjusted}$OR 4,67; 95% CI 1,20; 18,14), klinički stadijum bolesti ($_{adjusted}$OR 3,73; 95% CI 1,94; 7,18), davanje postoperativne antikoagulantne terapije ($_{adjusted}$OR 0,05; 95% CI 0,01; 0,23) i korišćenje inhibitora angiotenzin konvertujućeg enzima ($_{adjusted}$OR 0,14; 95% CI 0,03; 0,70). Značajan zajednički uticaj imale su sledeće kombinacije posmatranih faktora rizika: tip femoropoplitealnog bajpasa i kardiovaskularnih oboljenja, tip femoropoplitealnog bajpasa i prethodnih vaskularnih postupaka, prethodnih vaskularnih postupaka i kardiovaskularnih oboljenja, prethodnih vaskularnih postupaka i upotrebe beta blokatora, kardiovaskularnih oboljenja i dijabetesa, tip femo-

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ropoplitealnog bajpasa i antiagregacione terapije, kliničkog stadijuma bolesti i kardiovaskularnih oboljenja, prethodnih vaskularnih postupaka i antiagregacione terapije. **Zaključak.** Prateća kardiovaskularna oboljenja, potkoleni femoropoplitealni bajpas, uznapredovali stadijum vaskularne bolesti i nekorišćenje antikoagulantne terapije i inhibitora angiotenzin-konvertujućeg enzima značajni su prediktori okluzije grafta

nakon sintetskog femororpoplitealnog bajpasa. Zajednički uticaj ukazuje i na značaj dijabetesa, upotrebe beta blokatora i trombocitne antiagregacione terapije.

Ključne reči:
vaskularni graft, okluzija; biokompatibilni materijali; a. femoralis; v. saphena; faktori rizika.

Introduction

Femoropopliteal (FP) bypass is a revascularization technique of lower extremities with the excellent outcome. The great saphenous vein is the best graft material for FP bypass in patients with peripheral arterial occlusive disease [1] and compared to synthetic graft has better patency and limb salvage [2]. If the great saphenous vein is not adequate or has been removed, synthetic grafts appear to be the useful alternative. The initial outcome after FP bypass is good graft patency and blood supply [1]. In approximately 40% of patients with chronic critical limb ischemia within 6 months a major limb amputation is necessary if revascularization of the extremity has been not done [3].

Graft occlusion is the most significant complication with the most serious consequences after FP bypass revascularization. According to the time of onset, occlusion is classified into early (< 30 days), intermediary (30 day–2 years) and late (> 2 years) [4, 5]. Graft occlusion occurs in 25–35% of patients within 2 years after synthetic FP bypass reconstruction [4, 6, 7].

Literature review shows that FP bypass graft occlusions are related to patient age [8], gender [9, 10], race [8], the clinical stage of vascular disease [1, 4, 9, 11, 12], type of FP bypass [4, 11], type of graft [9, 13] and previous vascular interventions [2, 12, 14–16].

The literature shows contradictory and rare results of the effects of concomitant chronic disease, medications [8, 11, 15, 17, 18], and smoking [8, 12] on graft occlusions after synthetic FP bypass.

The aim of this research was to analyse the significance of insufficiently known and contradictory predictive factors for synthetic FP bypass graft occlusions according to previous studies, as well as their mutual interaction (possible additive effect of potential risk factors).

Methods

In this retrospective case-control study we examined potential risk factors for the development of graft occlusion after no heparinized synthetic [Dacron collagen coated (polyethylene terephthalate); expanded PTFE (polytetrafluoroethylene)] FP bypass. Data were collected from the medical documentation of the patients.

This study included all patients with FP bypass due to peripheral arterial occlusive disease at the Vascular Surgery Center, Clinical Center of Kragujevac, Serbia, during the 7-year period, from 2007 to 2013. Criteria for femoropopliteal bypass were type C and D lesions by TransAtlantic Intersociety Consensus (TASC) classification. Indications for op-

erative treatment of femoropopliteal bypass were significant intermitent claudication and critical limb ischemia. The average follow-up period after FP bypass was 42 months. After FP bypass the therapy with statins was not given on routine basis. The cases group were the patients with FP early, intermediary and late graft occlusion, and the control group consisted of patients without such an outcome. The graft occlussion after FP bypass determination was based on the clinical, ultrasound and angiografic examinations with patients who were coming on regural checkups. The study was approved by the Ethics Committee of the Clinical Center Kragujevac (01-728/2014).

The case group included the patients with detected graft occlusion after synthetic FP bypass. A control group consisted of patients without graft occlusions after synthetic FP bypass. Patients with incomplete data were not included in the study. We found out 4 patients with incomplete medical documentation (one patient had occlussion of the graft).

We used a case-control design matched by age and gender. Two controls were randomly selected for each case-group patient with more controls, utilizing the Excel RANDBETWEEN function. The degree of exposure to risk factors that we studied (independent variables) was determined by statistical analysis of medical records of the cases group and the controls.

With such parameters, there was a total of 132 subjects in both groups: 44 in the group of cases and 88 controls, with the proviso that the patients be distributed between the groups in the ratio of 1 : 2 (for each patient from the group of the cases there were two control patients).

Inclusion criterion was: already underwent synthetic FP revascularization of lower extremities due to chronic peripheral arterial occlusive disease.

Exclusion criterion was: patients with incomplete medical records.

The variables measured in the study were: independent variables (causes) – clinical stage of disease according to Rutherford criteria, previous vascular intervention (aorto-bifemoral bypass, contralateral amputation, ipsilateral and contralateral FP bypass, graft revision and endovascular procedures), the type of supporting medicaments (antiaggregation, anticoagulant, antihypertensive, and other) and tobacco use; dependent variables (outcome) was: graft occlusion after synthetic FP bypass; confounding variables were: gender, age, concomitant chronic disease (cardiovascular disease, diabetes, and other).

Continuous variables were reported as mean ± standard deviation (SD) in the text and tables, and categorical variables were presented as proportions. Student's *t*-test was

used for independent (small) samples when comparing the mean values of continuous variables and alternative non-parametric test was used if the outcome did not follow a normal distribution (the Kolmogorov-Smirnov test χ^2 test was used to examine differences between categorical variables, and Fisher's test was used if the frequency of certain samples was low. The effect of independent and confounding variables on the dichotomous outcome (graft occlusion after synthetic FP bypass) and mutual interaction of predictor variables were analyzed using binary logistic regression, and the results were presented as adjusted odds ratios (OR). Statistically significant results were all the results where the probability of the hypothesis is less than 5% ($p < 0.05$). The results were presented in the tabelar

form. The software package SPSS, the version 18.0, was used for statistical analysis.

Results

Baseline characteristics of participants and the differences between them are presented in Table 1.

The results of logistic regression analysis (Coh & Snell R square 0.439, Nagelkerke R square 0.610, Hosmer-Lemeshow χ^2 2.414, df = 8, $p = 0.966$) with the adjustment for potential confounders are given in Table 2.

Confounding factors that increase the risk for the occurrence of occlusions after synthetic FP bypass were found for: the concomitant cardiovascular disease ($_{adjusted}$OR 27.05; 95%

Table 1

Baseline characteristics of the cases and the controls

Variable	Cases (n = 44)	Controls (n = 88)	Test value and significance	Crude odds ratios with confidence intervals (1.96 SE)
Sex (M/F)	13/31	24/64	$\chi^2 = 0.75$ $p = 0.784$	0.89 (0.40; 1.99)
Age (years), mean ± SD	62.66 ± 8 .88	63.52 ± 9.17	$t = -0.515$ $p = 0.607$	0.99 (0 .95; 1.03)
Clinical stage of the disease according to Rutherford, n				
I	0	0		
II	0	16		
III	4	21	$\chi^2 = 16.24$	1.88 (1.31; 2.70)
IV	15	21	$p = 0.006$	
V	20	23		
VI	5	7		
Previous vascular intervention (no/yes), n	28/16	66/22	$\chi^2 = 1.85$ $p = 0.174$	1.71 (0.78; 3.74)
Cardiovascular diseases (no/yes), n	7/37	35/53	$\chi^2 = 7.70$ $p = 0.006$	3.49 (1.40; 8.70)
Diabetes (no/yes), n	30/14	61/27	$\chi^2 = 0.02$ $p = 0.89$	1.05 (0.48; 2.30)
Type of femoropopliteal bypass (above-knee, below-knee), n	12/32	57/31	$\chi^2 = 16.53$ $p = 0.001$	4.90 (2.21; 10.85)
OAC (yes/no), n	34/10	50/38	$\chi^2 = 5.30$ $p = 0.021$	0.39 (0.17; 0.88)
Platelet AA (acetylsalicylic acid and clopidogrel/ acetylsalicylic acid/ clopidogrel/without acetylsalicylic acid and clopidogrel), n	8/20/2/14	30/33/0/25	$\chi^2 = 7.16$ $p = 0.067$	1.22 (0.89; 1.65)
ACE inhibitors (no/yes), n	14/30	27/61	$\chi^2 = 0.51$ $p = 0.774$	0.94 (0.43; 2.03)
Beta blockers (no/yes), n	26/18	51/37	$\chi^2 = 0.02$ $p = 0.901$	0.95 (0.46; 1.99)
Duration of smoking (years), mean ± SD	29.45 ± 15 .05	26.24 ± 16 .55	$U = 1764.0$ $p = 0.40$	1.01 (0.99; 1.04)

SE* – significant difference; SD – standard deviation; OAC – postoperative vitamin K antagonist oral anticoagulant therapy (warfarin or acenokumarol) to INR (2–3); AA – postoperative antiaggregant therapy (acetylsalicylic acid or clopidogrel); ACE – angiotensin-converting enzyme.

Table 2

Crude and adjusted odds ratios of the risk factors

Risk factors	Crude OR (95%CI)	Adjusted OR (95%, CI)
Cardiovascular disease	3.49 (1.40–8.70)	27.05 (4.74, 154.35)
Type of femoropopliteal bypass (above-knee, below-knee)	4.90 (2.21–10.85)	16.50 (4.05, 67.24)
Previous vascular intervention	1.71 (0.78–3.74)	4.67 (1.20, 18.14)
Clinical stage of disease according to Rutherford	1.88 (1.31–2.70)	3.73 (1.94, 7.18)
ACE inhibitors	0.94 (0.43–2.034)	0.14 (0.03, 0.70)
OAC	0.39 (0.17–0.88)	0.05 (0.01, 0.23)

CI – confidence intervals; OR – odds ratio (for the sake of clarity only significant associations are shown in the table (95% CI of adjusted OR does not include value of 1); ACE – angiotensin-converting enzyme; OAC – postoperative vitamin K antagonist oral anticoagulant therapy (warfarin or acenokumarol) to INR (2–3).

CI 4.74; 154.35), type of FP bypass ($_{adjusted}$OR 16.50; 95% CI 4.05; 67.24), previous vascular intervention ($_{adjusted}$OR 4.67; 95% CI 1.20; 18.14), clinical stage of disease according to Rutherford ($_{adjusted}$OR 3.73; 95% CI 1.94; 7.18), the administration of postoperative oral anticoagulant (OAC) therapy ($_{adjusted}$OR 0.05; 95% CI 0.01; 0.23). Angiotensin-converting enzyme inhibitors (ACEI) plaied the protective role in the occurrence of graft occlusion after synthetic FP bypass ($_{adjusted}$OR 0.14; 95% CI 0.03; 0.70).

A significant synergistic effect was found for the combination of type of FP bypass and cardiovascular disease ($_{adjusted}$OR 32.76; 95% CI 7.31; 146.81), type of FP bypass and previous vascular intervention ($_{adjusted}$OR 7.56; 95% CI 1.58; 36.26), previous vascular intervention and cardiovascular disease ($_{adjusted}$OR 7.31; 95% CI 1.77; 30.20), previous vascular intervention and beta blockers ($_{adjusted}$OR 5.79; 95% CI 1.13; 29.56), cardiovascular disease and diabetes ($_{adjusted}$OR 4.37; 95% CI 1.17; 16.23), type of FP bypass and platelet antiaggregant therapy ($_{adjusted}$OR 2.60; 95% CI 1.42; 4.74), clinical stage of disease according to Rutherford and cardiovascular disease ($_{adjusted}$OR 2.47; 95% CI 1.68; 3.63), previous vascular intervention and platelet antiaggregant (AA) therapy ($_{adjusted}$OR 2.13; 95% CI 1.01; 4.52), postoperative OAC therapy and ACEI ($_{adjusted}$OR 0.09; 95% CI 0.02; 0.39) (Table 3).

By examining more risk factors, there was a synergistic effect found between the previous vascular intervention, cardiovascular disease and diabetes ($_{adjusted}$OR 9.98; 95% CI 1.42; 70.16); previous vascular intervention, cardiovascular disease

cording to Rutherford, cardiovascular disease and type of FP bypass ($_{adjusted}$OR 2.15; 95% CI 1.59; 2.91).

We have determined that the angiographic patency of three, two or one crural recipient artery in the group of cases was observed in 11, 14 and 19 patients (25.0%, 31.8%, and 43.2%, respectively), and in the group of controls it was observed in 29, 36 and 23 patients (33.0%, 40.9%, and 26.1%, respectively). In the group of cases there were 11 patients with Dacron and 33 patients with PTFE graft (25% and 75%, respectively). In the group of controls there were 58 patients with Dacron and 30 patients with PTFE graft (65.9% and 34.1%, respectively) The femoropopliteal patency before the occlusion appeared was on the average 317.95 ± 123.49 days. From the 44 patients that were in the group of cases, the amputation of the limb after the occlusion of the graft was necessary for 23 (52.27%) patients. Perioperative surgical site infections after femoropopliteal bypass were found in 6.82% (9/132) of the patients.

Discussion

We matched the patients in the study by sex and age, given the proven impact of predictive factors on graft occlusion [2, 9–12, 18] after synthetic FP bypasses to determine the significance of other variables.

If the great saphenous vein is not available Dacron has a small patency benefit if compared to PTFE in above-knee FP

Table 3

Synergistic effects of the risk factors

Risk factors	Crude OR (95%, CI)	AdjustedOR (95%, CI)
Type of femoropopliteal bypass and Cardiovascular disease	5.58 (2.54, 12.25)	32.76 (7.31, 146.81)
Type of femoropopliteal bypass and Previous vascular intervention	4.56 (1.56, 13.33)	7.56 (1.58, 36.26)
Previous vascular intervention and Cardiovascular disease	2.47 (1.05, 5.79)	7.31 (1.77, 30.20)
Previous vascular intervention and Beta blockers	1.56 (0.58, 4.20)	5.79 (1.13, 29.56)
Cardiovascular disease and Diabetes	1.75 (0.76, 4.04)	4.37 (1.17, 16.23)
Type of femoropopliteal bypass and platelet AA	1.69 (1.18, 2.40)	2.60 (1.42, 4.74)
Clinical stage of disease according to Rutherford and Cardiovascular disease	1.47 (1.21, 1.80)	2.47(1.68, 3.63)
Previous vascular intervention and platelet AA	1.36 (0.90, 2.07)	2.13(1.01, 4.52)
Clinical stage of disease according to Rutherford and Type of femoropopliteal bypass	1.48 (1.24, 1.76)	1.97(1.47, 2.64)
Clinical stage of the disease according to Rutherford and Diabetes	1.08 (0.92, 1.28)	1.30(1.02, 1.66)
Clinical stage of the disease according to Rutherford and platelet AA	1.12 (1.04, 1.21)	1.26(1.10, 1.44)
OAC and ACE hibitors	0.45 (0.18, 1.14)	0.09(0.02, 0.39)
Previous vascular intervention and Cardiovascular disease and Diabetes	2.69 (0.68, 10.58)	9.98(1.42, 70,16)
Cardiovascular disease and Type of femoropopliteal bypass and ACE inhibitors	4.21 (1.94, 9.15)	9.55(3.12, 29.25)
Previous vascular intervention and Cardiovascular disease and Type of femoropopliteal bypass	4.02 (1.35, 11.93)	6.97(1.55, 31,41)
Cardiovascular disease and Type of femoropopliteal bypass and platelet AA therapy	2.04 (1.31, 3.16)	3.00(1.55, 5.78)
Clinical stage of the disease according to Rutherford and Cardiovascular disease and Type of femoropopliteal bypass	1.52 (1.27, 1.81)	2.15(1.59, 2.91)

CI – confidence intervals; OR – odds ratio; AA – postoperative antiaggregant therapy (acetylsalicylic acid and clopidogrel/acetylsalicylic acid/clopidogrel/without acetylsalicylic acid and clopidogrel); OAC – postoperative vitamin K antagonist oral anticoagulant therapy (warfarin or acenokumarol) to INR (2–3); ACE – angiotensin converting enzyme; AA – postoperative antiaggregant therapy (acetylsalicylic acid and clopidogrel/acetylsalicylic acid/clopidogrel/without acetylsalicylic acid and clopidogrel).

and type of FP bypass ($_{adjusted}$OR 6.97; 95% CI 1.55; 31.41); cardiovascular disease, type of FP bypass and platelet AA therapy ($_{adjusted}$OR 3.00; 95% CI 1.55; 5.78); clinical stage of disease ac-

reconstruction [19, 20] and PTFE graft is an alternative to a below-knee FP bypass [4, 21]. We used a Dacron graft for above-knee and PTFE graft for below-knee FP bypass.

We found that cardiovascular disease is important risk factor for the development of graft occlusion after synthetic FP bypass. According to the literature, accompanying cardiovascular diseases indicate poor graft patency [2] and limb salvage (HR 3.68, 95% CI 1.51–8.94) [22] and in such patients the endovascular approach is recommended [23]. These results suggest that in patients with peripheral arterial occlusive disease and concomitant coronary artery disease is necessary to conduct adequate cardiac and arterial blood pressure monitoring for long-term patency of synthetic FP bypass.

In this study we determined the statistical significance of the type of FP bypass for graft occlusion after synthetic FP bypass and these results also correspond to the previous research [9]. We conclude that in patients with synthetic FP below-knee bypass there is an increased risk of graft occlusion [6, 11].

We noted that previous vascular intervention (aorto-bifemoral bypass, contralateral amputation, ipsilateral and contralateral FP bypass, graft revision and endovascular procedures) are important risk factors for the development of graft occlusions after synthetic FP bypass. These results indicate that in patients with vascular and endovascular interventions there is the increased risk of graft occlusion due to advanced vascular disease. Similar results have been shown in other studies [2, 15, 24]. One-year graft occlusion after bypass procedure is significantly higher in patients with prior vascular intervention (31% vs 20%; $p = 0.046$ and 28% vs 18%; $p = 0.009$) [15].

In our study clinical stage of disease according to Rutherford criteria is an important risk factor for the development of graft occlusions after synthetic FP bypass. Our conclusion is that there is an increased risk of graft occlusion in patients with advanced atherosclerosis and clinical stage of peripheral arterial occlusive disease of the lower extremity, especially in those with chronic critical limb ischemia. These results are consistent with other studies that show the importance of clinical stage of disease for graft occlusion [2, 6, 8, 12, 25, 26]. The difference in patency and limb salvage rate among patients surgically treated for intermittent claudication, pain at rest or tissue loss was statistically significant [4].

We determined a statistical significance of ACEI for graft occlusions. The use of ACEI can play important role in prevention of atherosclerosis, delay of its progression and reduction of vascular events. ACEI play the protective role in the occurrence of graft occlusion after synthetic FP bypass because they reduce the likelihood of occlusion.

We found a significant difference in the prevention of graft occlusion after synthetic FP bypass associated with postoperative vitamin K antagonist, OAC therapy. The use of adequate OAC therapy reduces the likelihood of synthetic FP graft occlusion. Increase in the risk of graft occlusion and ischemia without the use of OAC indicated that OAC therapy was useful especially in PTFE graft [27]. OAC may be specially useful for FP bypass procedure with a low flow (midgraft velocity ≤ 45 cm/s) [1].

A synergism was observed in several risk factors (Table 3). Some of these interactions were also shown in previous studies [2, 15, 17, 28–31], and some were shown here for the first time. Synergistic effect determined the importance of diabetes, arterial hipertension and the use of platelet AA therapy. This result indicates that in diabetic patients with advanced chronic critical limb ischemia, and the accompanying cardiovascular disease, there is an increased risk of graft occlusion after synthetic FP bypass [2, 15, 30]. Also, arterial hypertension increased risk of graft occlusion after synthetic FP bypass. .In patients with advanced vascular disease, concomitant cardiovascular disease and below-knee type of bypass, use of platelet AA after synthetic FP bypass decreased risk of graft occlusion.

A major hindrance in the study was its limitation to one center and its retrospective design. Despite the useful strategies for minimization of possible subjectivity in sampling and measuring the outcomes, such as case-control matching, a lot of patients were not included due to incomplete patient files, and true randomization of matched controls was not possible. These circumstances hampered our ability to analyse the impact of some potentially important factors on the occurrence of graft occlusion after synthetic FP bypass.

The modern trend in vascular surgery is the use of a hybrid method, where in the same patient during the same operation both vascular and endovascular procedures are performed. The hybrid method provides the possibility of simultaneous improvement of the outflow by performing angioplasty of tibial artery during the femoropopliteal reconstruction, thereby reducing the risk of graft occlusion [32].

Conclusion

Concomitant cardiovascular disease, below-knee femoropopliteal bypass, advanced stage of vascular disease and chronic limb ischemia were significant risk factors for graft occlusion after synthetic femoropopliteal bypass. Angiotensin converting enzyme inhibitors and postoperative oral anticoagulant therapy play the protective role against the occurrence of graft occlusion after synthetic femoropopliteal bypass. Synergistic effect determines the importance of diabetes, use of beta blockers and platelet antiaggregant therapy.

Identifying risk factors enables more effective preventive actions and modification by reducing incidence of graft occlusions, major amputation or disability of the patient. Further studies will identify additional risk factors, and achieve better graft patency rates after synthetic femoropopliteal bypass.

Acknowledgements

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