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Long-term graft occlusion in aortobifemoral position

Kasna okluzija grafta u aortobifemoralnoj poziciji

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Abstract

Background/Aim. Aortobifemoral (AFF) bypass is still the most common surgical procedure used in treatment of aortoiliac occlusive disease. One of the most common complications of AFF bypass procedure is long-term graft oclussion. The aim of this study was to determine the cause of long-term graft occlusion in AFF position, as well as the results of early treatment of this complication. **Methods.** This retrospective study, performed at the Clinic of Vascular and Endovascular Surgery, Clinical Center of Serbia in Belgrade, involved 100 patients treated for long-term occlusion of bifurcated Dacron graft which was ensued at least one year after the primary surgical procedure. **Results.** The most common cause of the long-term graft occlusion was the process at the level of distal anastomosis or below it ($Z = 3.8$, $p = 0.0001$). End-to-end type of proximal anastomosis has been associated with a significantly increased rate of long-term graft occlusion ($Z = 2.2$, $p = 0.0278$). Five different procedures were used for the treatment of long-term graft occlusion: thrombectomy and distal anastomosis patch plasty (46% of the cases); thrombectomy and elongation (26% of the cases); thrombectomy and femoropopliteal bypass (24% of the cases); crossover bypass (2% of the cases) and a new AFF bypass (2% of the cases). The primary early graft patency was 87%. All 13 early occlusions occurred after the thrombectomy associated with patch plasty of distal anastomosis. Thrombectomy with distal anastomosis patch plasty showed a statistically highest percentage of failures in comparison to thrombectomy with graft elongation, or thrombectomy with femoro-popliteal bypass ($Z = 2\,984$, $p = 0.0028$). Redo procedures were performed in all the cases of early occlusions. In a 30-day follow-up period after the secondary surgery, 90 (90%) patients had their limbs saved, and above knee amputation was made in 10 (10%) patients. **Conclusion**. Long-term AFF bypass patency can be obtained by proximal end-to-end anastomosis on the juxtarenal part of aorta and distal anastomosis on the bifurcation of the common femoral, or on the deep femoral artery.

Key words:
graft occlusion, vascular; risk assessment; diagnosis; comorbidity; aortic diseases; vascular surgical procedures.

Apstrakt

Uvod/Cilj. Aortobifemoralni (AFF) bajpas još uvek je najčešća hirurška procedura koja se koristi u lečenju aortolijačne okluzivne bolesti. Jedna od najčešćih komplikacija AFF bajpas procedure je kasna okluzija grafta. Cilj ovog rada bio je utvrđivanje uzroka kasnih okluzija grafta u poziciji AFF i ranih rezultata lečenja ove komplikacije. **Metode.** Retrospektivnom studijom u Klinici za vaskularnu i endovaskularnu hirurgiju Kliničkog Centra Srbije u Beogradu bilo je obuhvaćeno 100 bolesnika kod kojih je lečena kasna okluzija bifurkacionih Dacron graftova, nastala najmanje godinu dana posle primarne operacije. **Rezultati.** Najčešći uzrok kasne okluzije grafta bio je proces u predelu distalne anastomoze (njeno postavljanje na zajedničku butnu arteriju ili neointimalna hiperplazija) ili ispod nje (distalna progresija okluzivne bolesti) ($Z = 3{,}8$; $p = 0{,}0001$). Terminolateralna forma proksimalne anastomoze statistički je značajno povećavala stopu kasnih okluzija ($Z = 2{,}2$; $p = 0{,}0278$). U lečenju kasne okluzije primenjivani su: trombektomija grafta i *patch* plastika distalne anastomoze – 46% bolesnika; trombektomija grafta i njegova elongacija na duboku butnu arteriju – 26%; trombektomije grafta i dopunski femoropoplitealni bajpas – 24%; *cross over* bajpas – 2% i novi AFF bajpas – 2% bolesnika. Rana prohodnost iznosila je 87%. Svih 13 ranih okluzija nastale su nakon trombektomije grafta udružene sa *patch* plastikom distalne anastomoze. Statistička analiza je pokazala da je u odnosu na

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trombektomiju grafta sa elongacijom na duboku butnu arteriju, odnosno trombektomiju grafta sa femoropoplitealnim bajpasom, ova procedura opterećena statistički najvećim procentom neuspeha (Z = 2, 984; p = 0,0028). U svim slučajevima rane okluzije izvedena je ponovna intervencija. Ukupan broj spašenih ekstremiteta u prvih 30 dana bio je 90 (90%), dok je u istom periodu urađeno ukupno 10 natkolenih amputacija (10%). **Zaključak.** Udaljena prohodnost AFF bajpasa može se produžiti proksimalnom anastomozom terminoterminalnog tipa na jukstarenalnoj aorti, i distalnom anastomozom na bifurkaciji zajedničke femoralne ili dubokoj butnoj arteriji.

Ključne reči:
vaskularni graft, okluzija; rizik, procena; dijagnoza; komorbiditet; aorta, bolesti; hirurgija, vaskularna, procedure.

Introduction

Aortobifemoral (AFF) bypass is still the most common surgical procedure used in treatment of aortoiliac occlusive disease. Compared to other procedures, AFF reconstruction provides the best long-term results. From the middle of the last century, when AFF reconstruction was first performed [1], this surgical procedure has been continuously improving, but it is still very complex. One of the most common complications of AFF bypass procedure is long-term graft occlusion. The frequency of this complication is 0.9%–20% [2–13] in a 5-year period following surgery, and 20%–40% [13–15] in a 10-year period. The aim of this study was to determine the cause of long-term graft occlusion in AFF position, as well as the results of early treatment (within first 30 days) of this complication.

Methods

This retrospective study, performed at the Clinic of Vascular and Endovascular Surgery, Clinical Center of Serbia, Belgrade included 100 patients with long-term bifurcated Dacron graft occlusion ensued at least one year after AFF reconstruction. This study did not include patients with AFF reconstruction of abdominal aortic aneurysm treating, patients previously treated for occlusive disease of the abdominal aorta, patients with polytetrafluoroethylene (PTFE) graft AFF reconstruction and patients with surgical procedure on the iliac or femoral arteries.

Tabular and graphical presentation of the data and methods of descriptive statistics (mean value, standard deviation, Student t-test, χ2-test, test for a single proportion) were used for statistical analysis.

Results

Table 1 shows the demographic characteristics of patients; risk factors; cardiovascular comorbidity; clinical presentation; period from primary surgery to the occurrence of the long-term graft occlusion and type of graft occlusion.

The average age of patients was 59.88 ± 8.57 years. The youngest patient was 37, and the oldest one 75 years old. Most patients were male (82 or 82%). Arterial hypertension was present in 43% of the patients. Out of the patients, 35% were smokers, and nine (9%) patients were overweight. Diabetes mellitus was found in 13% of the patients. Nineteen patients had cerebrovascular disease [transient ischemick atack (TIA, stroke, previous carotid endarterectomy)], and 50 (50%) patients had ischemic heart disease (myocardial infarction, angina pectoris).

Table 1

The demographic characteristics of patients, risk factors, cardiovascular comorbidity, clinical presentation, and a period from primary surgery to the occurrence of long-term graft occlusion and graft occlusion type

Characteristics	Patients number (%)
Age (years), $\bar{x}$ ± SD (range)	59.88 ± 8.57 (37–75)
Gender	
male	82 (82.00)
female	18 (18.00)
Risk Factors	
arterial hypertension	43 (43.00)
obesity	9 (9.00)
smoking	35 (35.00)
diabetes mellitus	13 (13.00)
Cardiovascular Comorbidity	
cerebrovascular disease	19 (19.00)
ischemic heart disease	50 (50.00)
Clinical Presentation	
claudication discomfort	24 (24.00)
acute limb ischemia	65 (65.00)
gangraena	11 (11.00)
Occlusion type	
unilateral occlusion	76 (76.00)
bilateral occlusion	24 (24.00)
Time from primary surgery to the late graft occlusion	4.47 ± 3.94 (1–16) years

The majority (65%) of the patients had acute, while 35% chronic limb ischemia (24% of the patients had claudication discomfort and 11% gangrene). A total of 76% of the patients had unilateral and 24% bilateral graft occlusion. The average time period from AFF reconstruction to long-term graft occlusion was 4.47 (1–16) years.

The most common (50% of the cases) cause of long-term graft occlusion was neointimal hyperplasia. Proximal progression of the occlusive disease was the cause of long-term grafts occlusion in 4.72% of the cases. In 33.02% of the cases the cause was distal progression of occlusive disease, and graft failure in 12.26% of the cases. The causes of long-term occlusion after AFF bypass are shown in Table 2. Influence of proximal anastomosis type and site of distal anastomosis on long-term graft occlusion is shown in Table 3.

End-to-side type of proximal anastomisis was associated with long-term graft occlusion in 64.89% of the cases and end-to-end type in 35.11%. It was statistically significant ($Z = 2.2$, $p = 0.0278$). Distal anastomosis of AFF bypass was located on the common femoral artery in 70.41% of the cases with long-term graft occlusion. It was statistically significant ($Z = 3.8$, $p = 0.0001$).

Five surgical procedures in treatment of long-term AFF bypass occlusion were used (Table 4) graft thrombectomy and distal anastomosis patch plasty (46% of the patients) graft thrombectomy and its elongation on the deep femoral artery (26% of the patients), graft thrombectomy and femoropopliteal bypass (24% of cases), cross-over bypass (2% of cases) and a new AFF bypass (2% of the patients). In the first 30 postoperative days there was no mortality, while 13 (13%) cases with early graft occlusion were found. The primary early graft patency was 87%. All 13 cases with early occlusions occurred after graft thrombectomy associated with patch plasty of distal anastomosis. A graft thrombectomy associated with distal anastomosis patch plasty had a statistically highest percentage of failures ($Z = 2\ 984$, $p = 0.0028$).

Redo procedures were performed in all the cases of early graft occlusion after the secondary surgery. In five cases graft elongation on the deep femoral artery was performed. In other five cases we performed additional femoropopliteal bypass, while in three cases, due to disability of new revascularization, above knee amputations were necessary. In seven patients correction of long-term graft occlusion would not be able to provide adequate limb vascularization, and therefore, the above knee amputations were made. The limb salvage rate during a 30-day follow-up period after the secondary surgery was 90%. Above knee amputation was made in 10 (10%) patients. Several examples

Table 2

Causes of long-term graft occlusion after aortobifemoral bypass

Intraoperative finding	Occurence of intraoperative findings number (%)
Proximal progression of occlusive artery disease	5 (4.72)
Distal progression of occlusive artery disease	35 (33.02)
Neointimal hyperplasia	53 (50.00)
Graft failure	13 (12.26)
Total	106 (100.00)

Table 3

Influence of proximal anastomosis type and distal anastomosis site on long-term graft occlusion

Parameters	Number (%)	Z	*p*
Proximal anastomosis type			
end-to-end	33 (35.11)	2.2	0.0278
end-to-side	61 (64.89)		
Site of distal anastomosis			
common femoral artery	69 (70.41)	3.8	0.0001
deep femoral artery	29 (29.59)		

For six of the patients, data about proximal anastomosis type were not found; for two of the patients data about distal anastomosis site were not found, too.

Table 4

Procedures used in the treatment of long-term graft occlusion in aortobifemoral (AFF) position

Procedure	Patients number (%)	Early occlusion number (%)	*p*
Thrombectomy and distal anastomosis patch plasty	46 (46.00)	13 (28.2)	0.0028
Thrombectomy and graft elongation	26 (26.00)	0 (0.0)	
Thrombectomy and femoro-popliteal bypass	24 (24.00)	0 (0.0)	
Crossover bypass	2 (2.00)	0 (0.0)	
New AFF bypass	2 (2.00)	0 (0.0)	
Total	100 (100.0)	13 (13.0)	

of our documented experiences with long-term graft occlusion after AFF bypass reconstruction are shown in Figures 1–4. Recommended procedures in the treatment of long-term graft occlusion after AFF bypass reconstruction are shown in Figure 5.

Fig. 1 – A resected anastomotic part of the graft with a secondary thrombus and neointimal hyperplasia.

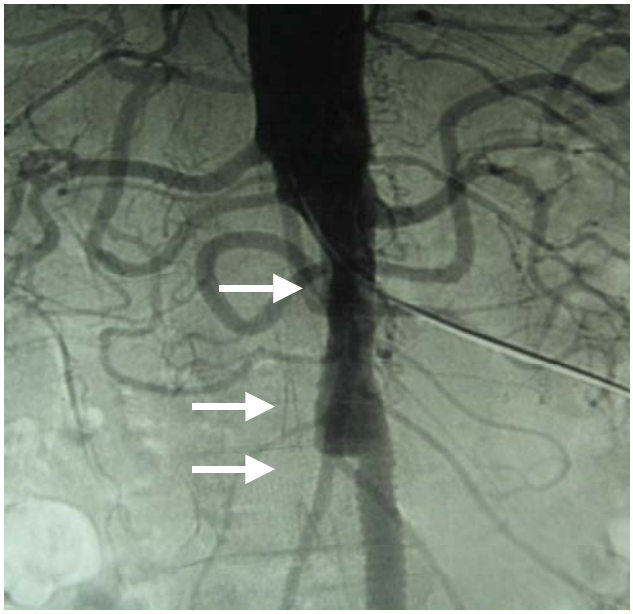


Fig. 2 – Control angiography after aortobifemoral reconstruction shows proximal progression of occlusive artery disease caused by low-set proximal anastomosis (arrow). The right limb of bifurcated graft is occluded (two arrows).

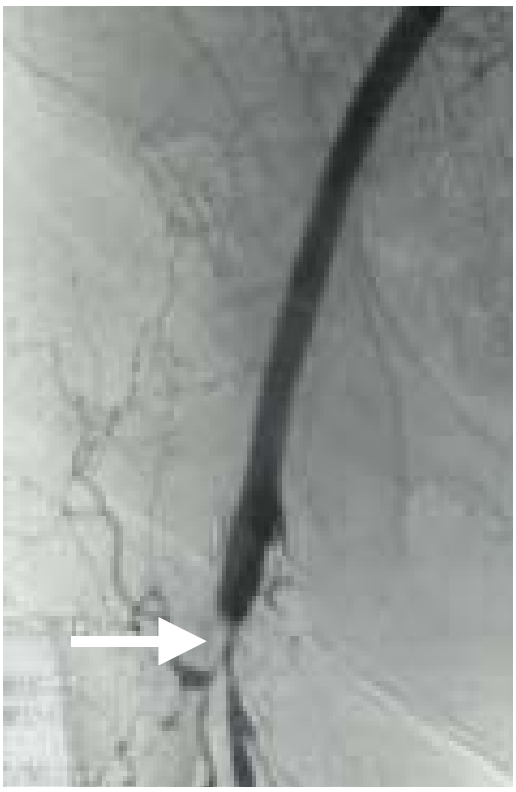


Fig. 3 – Control angiography shows stenosis at the level of the right distal anastomosis of aortobifemoral bypass (arrow) caused by distal progression of occlusive artery disease.

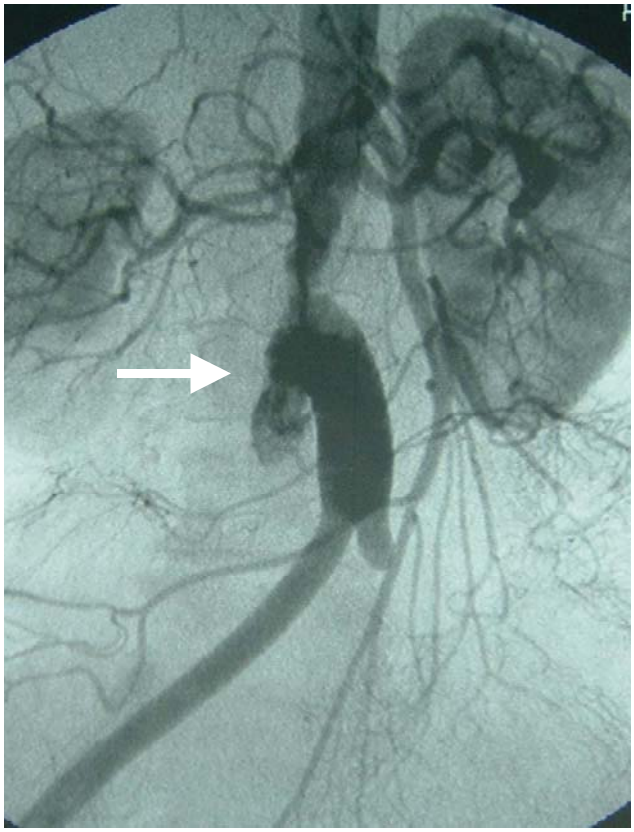
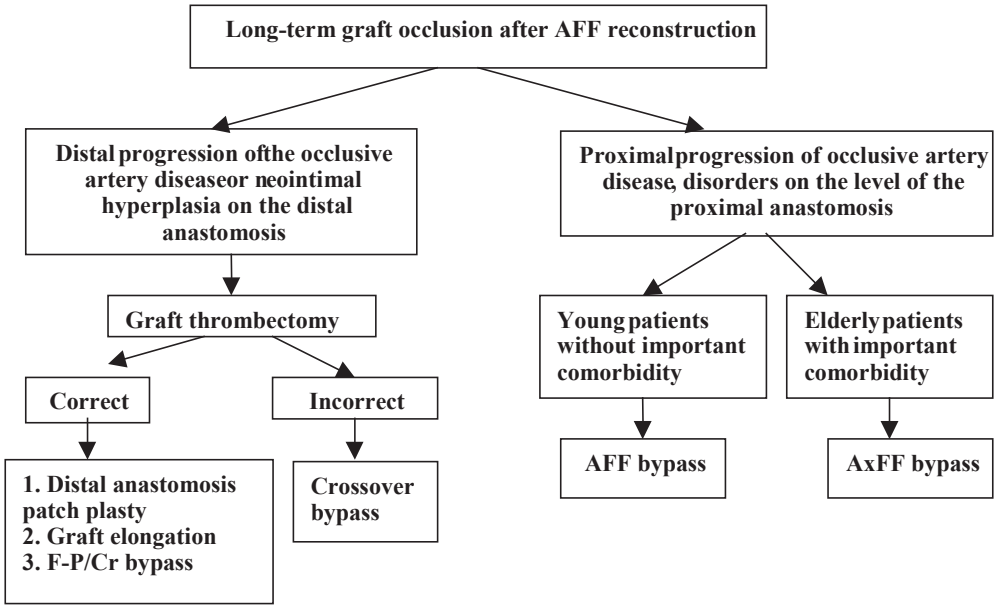


Fig. 4 – Control angiography after aortobifemoral bypass reconstruction with end-to-side type of proximal (arrow). The left limb of a bifurcated graft is occluded.



Legend: AFF – aortobifemoral bypass; DFA – deep femoral artery; F-P/Cr – femoro-popliteo/crural bypass; AxFF – axilobifemoral bypass.

Fig. 5 – Recommended procedures in treatment of long-term graft occlusion after AFF bypass reconstruction.

Discussion

There are several classifications of long-term graft occlusion causes after AFF reconstruction. Wesolowski [16] divided them into primary and secondary causes. Primary long-term graft occlusion is a consequence of graft failure, while secondary is caused by proximal or distal progression of occlusive artery disease. Causes of graft failure are kinking (22% by Szilagyi et al. [17]) and anastomotic stenosis caused by neointimal hyperplasia (2%–13%) [4, 9, 15, 17–20].

According to this classification, in our study 60 (60%) patients had primary, while 40 (40%) secondary long-term graft occlusion. If proximal anastomosis of AFF bypass is set just below the renal artery, proximal progression of occlusive artery disease is rarely the cause of long-term graft occlusion [4, 10]. In the early period of abdominal aortic surgery, low-set proximal anastomosis and proximal progression of occlusive artery disease, caused long-term graft occlusion in AFF position more frequently.

Crawford et al. [8, 9] find that the proximal progression of occlusive artery disease cause long-term graft occlusion in 13% of cases. Many other authors suggest that the distal progression of occlusive artery disease cause long-term graft occlusion most frequently [4, 9, 10, 20]. It especially often occurs in distal anastomoses created on the common femoral artery. Long-term AFF bypass patency can be improved by distal anastomosis on the femoral bifurcation, or on the deep femoral artery. Distal anastomosis of AFF bypass was made on the common femoral artery in 70.41% of our cases with long-term graft occlusion. It was statistically significant ($Z = 3.8$, $p = 0.0001$).

Becquemin´s et al. [20] classification of long-term graft occlusion cases after AFF bypass reconstruction is slightly different. There are neointimal hyperplasia, atherosclerosis, anastomotic process and others [20]. In his study, 36% of long-term graft occlusions were caused by neointimal hyperplasia, which was more common in younger patients with fewer risk factors. In this study 50% of the patients had femoral artery narrower than 5 mm, and 2% had large disproportion between the diameter of the graft and artery.

Atherosclerosis was the cause of long-term graft occlusion in 35% of Becquemin´s patients [20]. It was more frequent in elderly patients with multiple risk factors. Anastomotic process caused late graft occlusion in 6% of cases, and other reasons in 17% [20]. By Becquemin et al. [20], other reasons of long-term graft occlusion are hypercoagulability, infection, transient hypotension or unknown causes. Many different disorders are associated with hypercoagulability, such are obesity, malignancy, trauma, age, prolonged using of contraceptives, smoking, and reduced level of tissue plasminogen activator and antithrombin III [21]. Towne et al. [22] described seven cases of early or late thrombosis of synthetic grafts, caused by deficiency of antithrombin III. We did not find cases of long-term graft occlusion caused by hypercoagulability or by indeterminate causes. Other authors state that the causes of long-term graft occlusion remain indeterminated in 6%–24% of cases [8, 9, 18].

Having in mind all the classifications of long-term graft occlusion causes of AFF bypass, the simplest might be the one that includes the following four reasons: disorders on the level of proximal anastomosis or above it (low-set proximal anastomosis, end-to-side type of proximal anastomosis, proximal progression of occlusive artery disease), graft failure (untight graft, folded graft, graft torsion, external graft compression), disorders on the level of distal anastomosis or below it (neointimal hyperplasia, distal progression of occlusive artery disease). According to this classification, disorders on the level of proximal anastomosis or above it caused long-term graft occlusion in 5% of the cases in our study. In all the cases it was end-to-side type of proximal anastomosis.

In our study graft failure caused long-term graft occlusion in 13% of the cases, while disorders on the level of distal anastomosis or below it were the cause in 83% (neointimal hyperplasia was cause in 50% of the cases, and distal progression of occlusive artery disease in 33%).

If it is well indicated and technically correctly performed, bilateral graft occlusion of AFF bypass is relatively rare. In our study unilateral graft occlusion was in 76% of the cases, and bilateral in 24%. Bilateral graft occlusion usually ensues after a long follow-up period. The most likely reason of bilateral graft occlusion is low-set of proximal anastomosis [2–4]. End-to-side type of proximal anastomosis contributes to long-term graft occlusion because it has worse hemodynamic properties [2–4]. End-to-side type of proximal anastomosis was in all of our patients with complete graft occlusion, which was statistically significant ($Z = 2.2$, $p = 0.0278$).

In our study, the average time period from AFF reconstruction to graft occlusion was 4. 47 years. In Najafi´s et al.[10] study that period was 3.5 years. Le Grand et al. [23] say that 28% of unilateral graft occlusion occurs within the first months after surgery, and 72% within the first 30 months.

In 65% of our cases long-term graft occlusion of AFF bypass was manifested with acute, and 35% with chronic limb ischemia (claudication discomfort or gangrene). In Becquemin´s et al. [20] study, 63% of cases with long-term graft occlusion had claudication discomfort, 20% acute ischemia, while 2% of the patients were asymptomatic.

In the treatment of unilateral long-term graft occlusion, Crawford et al. [9] recommended complete graft replacement. They thought that previous graft, in graft preserving surgical procedure, is very thrombogenic. Therefore, that graft remains *locus minoris resistentiae*. We have done two new AFF bypasses. Most other authors consider that complete graft replacement should be avoided because it is associated with the morbidity (injury of the duodenum, injury of inferior caval vein, injury of ureter, extensive bleeding etc.) and mortality. Complete graft replacement is recommended in cases with bilateral occlusion, disorders on the level of proximal anastomosis or above it, elongated graft or folded graft [15, 17, 24]. These were our criteria for a complete graft replacement. Lower risk surgical procedures could be performed in treatment of unilateral graft occlusion. Bernhard et al. [18] think that the choice of procedure depends on the graft type, period from surgery to graft occlusion, period from graft occlusion to reintervention, clinical presentation, general condition of a patient, angiographic findings before primary surgery, angiographic findings after graft occlusion, and perioperative findings. They also state that only 60% of their patients with unilateral graft occlusion are treated within four weeks from the occlusion.

According to recommendations of the literature and the results from a different studies, we formulated the following preliminary conclusion about the type of long-term graft occlusion treatment [2–4, 18, 20, 23]. If late graft occlusion is caused by distal progression of occlusive artery disease or neointimalna hyperplasia on distal anastomosis, you should try the following procedures in the following order: correction of disorders at the level of distal anastomosis is necessary after successful graft thrombectomy; graft elongation on the deep femoral artery or on its lower part is the best treatment after thrombectomy; if deep femoral artery is not suitable for reconstruction, femoropopliteal/crural bypass should be done; "crossover" bypass should be performed in cases when graft thrombectomy is not possible. If AFF bypass occlusion is caused by graft failure or disorder on proximal anastomosis or above it, a new AFF (in younger patients with less perioperative risk) or axilo-bifemoral (in elderly patients with high perioperative risk) should be done.

All these procedures can be divided into three groups: procedures on the "inflow" tract ("crossover" bypass, AFF bypass and axillo-bifemoral bypass), procedures on the graft (thrombectomy), concomitant procedures on the graft (thrombectomy) and "outflow" tract (graft elongation or femoropopliteal/crural bypass).

Early graft occlusion after correction of AFF bypass occlusion ranges from 9.6% to 30% [18–20, 23, 25, 26]. We noticed 13 (13%) early graft occlusions after correction. All 13 early graft occlusions occurred after graft thrombectomy associated with patch plasty of distal anastomosis, which was statistically significant ($Z = 2, 984$, $p = 0.0028$).

Conclusion

Long-term AFF bypass patency can be obtained by proximal end-to-end anastomosis on the juxtarenal part of the aorta and distal anastomosis on the femoral bifurcation, or on the deep femoral artery. It is necessary to eliminate or control risk factors in a postoperative period. Long-term AFF bypass patency could be achieved by adequate secondary surgical procedure.

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