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Surgical interventions for autogenous arteriovenous fistula aneurysms in hemodialysis patients

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ABSTRACT

Objectives. The aim of this study was to emphasize the importance of surgical intervention perfotmed before development of arteriovenous fistula (AVF) aneurysm complications. ***Methods.*** The patients were categorized into two groups: Patients undergoing elective surgery for autogenous AVF aneurysm were defined as elective group (Group 1), whereas those who underwent emergency surgery due to ruptured aneurysmal fistulas were defined as emergency group (Group 2). All elective cases were evaluated by doppler ultrasonography before surgery. All patients had temporary hemodialysis catheters. In the patients with salvaged fistulas, the fistulas was rested for 1 week. A new fistula was created in patients with not salvaged fistula. ***Results.*** A total of 31 patients (54.8% male, mean age: 41.2 ± 14.7 years) were in Group 1 and 7 patients (57.1% male, mean age: 53 ± 9.4 years) were in Group 2. Significant difference was observed between two groups in terms of fistula preservation. Salvaged fistulas were significantly higher in the Group 1 than Group 2 ($p = 0.003$). In Kaplan-Meier curves, cumulative primary AVF patency rates at 1, 3 and 6 months were 96.3%, 81.5%, and 77.8% in Group 1 and 66.7%, 66.7%, and 66.7% in Group 2, respectively (log-rank; $p = 0.536$). ***Conclusions.*** Consultation of these cases with a cardiovascular surgeon before they reach the rupture stage is an important condition for both the patency of the fistula and the vital risk of the patient.

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Keywords: Arteriovenous fistula aneurysms, salvage treatment, hemodialysis

Introduction

Haemodialysis via an autogenous arteriovenous fistula (AVF) is the most frequently used treatment for end-stage renal failure worldwide [1]. Development of aneurysmal dilatation of the AVF is an important complication which occurs in 5-6% of the cases and has a significant risk of rupture [2]. Aneurysms are associated with multiple complications that increase the risk of life-threatening fistula bleeding, fistula loss, and even patient death [3]. In addition, aneurysms can cause tissue necrosis and erosion and local infection.

Pseudo-aneurysms can be caused by anastomotic leakage or may occur later as a complication of infection. However, true AVF aneurysms are occurs as a result of repeated intervention for vascular access to

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multiple small fibrous scars in the vessel wall, which may expand over time and may result in localized aneurysmal regions. Aneurysmal dilation also may occur in non-needled areas and the highflow though the vessel can cause in abnormal shear stress, which promotes outward remodeling and gradual dilation with grossly increased calibre of the vessel [4].

The aim of this study was to emphasize the importance of intervention performed before development of AVF aneurysm complications.

Methods

Patients

This retrospective observational study includes patients with end-stage renal failure who underwent surgery due to autogenous AVF aneurysms between 2014 and 2018 at Department of Cardiovascular Surgery, Bursa Yüksek İhtisas Training and Research Hospital,Turkey. The study was approved by institutional review committee.

All data retrieved from the hospital's medical files analyzed retrospectively. All data were recorded as age, gender, comorbidities (Hypertension, diabetes mellitus, coronary artery disease), type of AVF and duration of AVF. The patients were categorized into two groups: Patients undergoing elective surgery for autogenous AVF aneurysm were defined as elective group (Group 1), whereas those who underwent emergency surgery due to ruptured aneurysmal fistulas were defined as emergency group (Group 2). All elective cases were evaluated by doppler ultrasonography before surgery. All patients had temporary hemodialysis catheters. In the patients with salvaged fistulas, the fistulas was rested for 1 week. A new fistula was created in patients with not salvaged fistula.

Surgery

While all emergent procedures were carried out under general anaesthesia, elective procedures were carried out under local anaesthesia accompanied with sedation. Our priority was to stop the bleeding in emergency ruptured cases. The aneurysm sac was isolated from surrounding tissue to reach to the root of the aneurysm and then to the afferent and efferent arteries (Figure 1). Aneurysmal sacs were opened, after resecting the sacs, in cases with thrombus, thrombectomy was performed. Then appropriate graft materials were interposed between related artery and the previously dissected vein or between arterialized veins. Plication was performed in the presence of the suitable aneurysmal sac (Figures 2a and 2b).

Postoperative Evaluation

Postoperative fistula evaluation was done at 1st, 3rd, and 6th months. The follow-up continued until death or no further communication was possible to the patient. In such cases, data from the last visit were used. AVF patency was assessed by physical examination for the presence of a palpable thrill. In the absence of a palpable thrill and pulse, it was evaluated as failure. When presence of a palpable

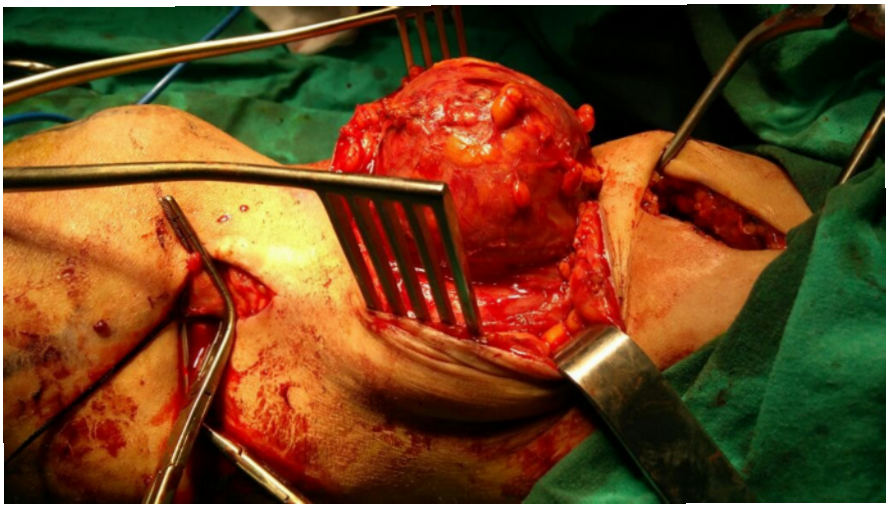


Figure 1. Aneurysm sac isolated from surrounding tissue.

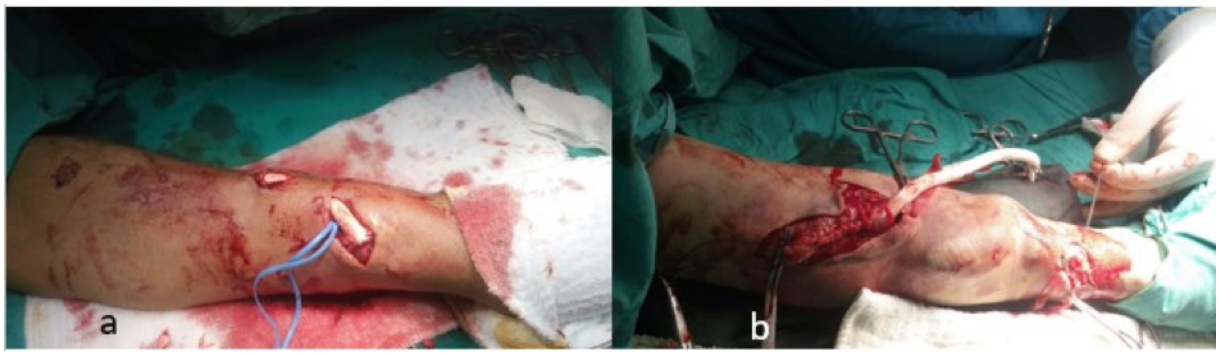


Figure 2. Graft interposition view after aneurysmectomy (a) and aneurysm plication view (b).

pulse, doppler USG was performed and blood flow measured. Those below the flow rate of 200 ml/min were considered as a failured AVF.

Statistical Analysis

Statistical analysis data were analyzed with the Statistical Package for the Social Sciences (IBM SPSS Statistic Inc. version 21.0, Chicago, IL, USA). Continuous and ordinal variables were expressed as mean ± standard deviation and nominal variables were expressed as frequency and percentage. Kolmogorov-Smirnov test and Shapiro-Wilk tests of normality were used to identify distribution of variables. Chi Square test and Fisher's Exact test were used to compare two groups for nominal variables. Student-t test was used to compare two groups for continuous variables normal distribution. Mann-Whitney U test was used to compare two groups for continuous variables without normal distribution. Long-term results were analyzed by Kaplan Meier curves, and differences in subgroups were assessed by the log-rank test. For all tests, a p value of < 0.05 was considered statistically significant.

Results

A total of 31 patients (54.8% male, mean age: 41.2 ± 14.7years) were in Group 1 and 7 patients (57.1% male, mean age: 53±9.4 years) were in Group 2. The demographic and clinical properties of the subjects are summarized in Table 1. Both groups were generally similar in regards to demographic properties. The size of aneurysm was 52.3 ± 14.5 mm in Group 1 and 68.6 ± 17.5 mm in Group 2. In terms of size of aneurysm there was statistically significant difference between two groups. ($p = 0.014$) (Table 1).

The reasons of the operations are shown in table 2 and the most common cause was skin thinning or ulceration (81.6 %). Some of treated aneurysms have shown in Figure 3a, 3b and 3c. All of the aneurysms operated were true aneurysms.

Table 1. Demographic features of the patients

Variables	Group 1 (n = 31)	Group 2 (n = 7)	*p* value
Age (years)	41.2 ± 14.7	53 ± 9.4	0.051*
Gender, n (male %)	17 (54.8)	4 (57.1)	0.912 [#]
Hypertension, n, %	19 (61.3)	6 (85.7)	0.219 [#]
Diabetes Mellitus, n, %	16 (51.6)	2 (28.6)	0.270 [#]
History of CAD, n, %	9 (29)	2 (28.6)	0.981[#]
Type of AVF			0.728 [#]
Brachiocephalic, n, %	20 (64.5)	5 (71.4)	
Radiocephalic, n, %	11 (35.5)	2 (28.6)	
Size of Aneurysm (mm) (min-max)	52.3 ± 14.5 (35-100)	68.6 ± 17.5 (45-100)	**0.014**[b]
Duration of AVF (years)	6 ± 2.6	7.9 ± 2.5	0.102*

Group 1= elective surgery, Group 2 = emergent surgery, CAD = Coronary Artery Disease, AVF = Arteriovenous Fistula, [#] Pearson Chi- Square, *Student's *t* test, [b] Mann Whitney Test

Table2. Indications of aneurysm for treatment

Causes of Surgery	**n = 38**
Skin thinning or ulceration, n (%)	31 (81.6)
Expanded aneurysm, n (%)	27 (71.1)
Rupture, n (%)	7 (18.4)
Pain with aneurysm, n (%)	4 (10.5)
Failure with thrombosis, n (%)	5 (13.2)

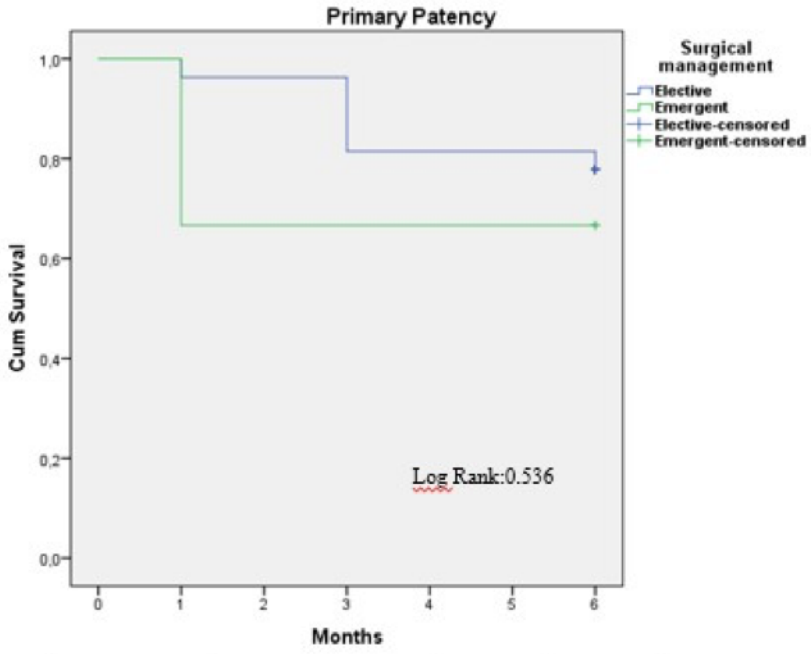
Figure 3. AVF aneurysm (a), AVF aneursym with skin thinning and ulceration (b), and ruptured AVF aneurysm (c).

The comparison of post-intervention fistulas status are shown in Table 3. Significant difference was observed between two groups in terms of fistula preservation. Salvaged fistulas were significantly higher in the Group 1 than Group (p = 0.003 [Pearson Chi-Square] and p = 0.013 [Fisher's Exact Test]) (Table 3). There was worse fistula rescue in Group 2. A total of 31 (81.6%) fistulas were salvaged. Three

Table 3. Post-intervention fistulas status

	Group 1 (n = 31)	**Group 2 (n = 7)**	***p value***
Salvaged AVF, n, %	28 (90.3)	3 (42.9)	[#] **0.003**
			[a] **0.013**
Not Salvaged AVF, n, %	3 (9.7)	4 (57.1)	[#] **0.003**
			[a] **0.013**

[#] Pearson Chi- Square, [a] Fisher's Exact Test, AVF = Arteriovenous Fistula



	Months	1	3	6
Salvaged AVF	N. at risk	27	23	19
	SE	0,036	0,075	0,080
	Patency rate	96.3 %	81.5 %	77.8 %
Not Salvaged AVF	N. at risk	2	2	2
	SE	0,272	0,272	0,272
	Patency rate	66.7 %	66.7 %	66.7 %

Figure 4. Kaplan-Meier curves; cumulative primary patency rates for six months.

fistulas in the elective group could not salvaged due to axillary or subclavian vein thrombosis. In twenty-five (80.6%) cases we performed aneurysm excision and repair with graft interposition. Aneurysm plication was applied to others.

The 6-month follow-up was completed in all patients. In Kaplan-Meier curves, cumulative primary AVF patency rates at 1, 3 and 6 months were 96.3%, 81.5%, and 77.8% in Group 1 and 66.7%, 66.7%, and 66.7% in Group 2, respectively (log-rank; $p = 0.536$) (Figure 4). In total, 7 (22.6%) AVF failure observed in the follow-up period.

Discussion

For patients with renal insufficiency, hemodialysis is an inevitable lifelong requirement until the renal transplant, and deprivation of the patient's vascular access pathway can be life-threatening. Many late complications, such as thrombosis, venous hypertension, aneurysm formation, hemorrhage, vascular steal syndrome, stenosis, and heart failure may occur following arteriovenous fistula surgery [5]. The treatment of the fistula complications should treat the problem and maintain the fistula function. In this study, we analyse the follow ups and the results of AVFs that we intervened due to aneurysm formation. In our study, we determined the preservation rate of the AVFs as 90.3% in electively operated group and as 42.9% in emergency operated group due to rupture ($p = 0.003$) (Table 3).

When aneurysm and tortuosity occur in AVF, cannulation may become difficult and flow might be unreachable due to thrombus formation in the aneurysm. Other sequelae of aneurysm's degeneration is corruption of the overlying skin that associated with risks of bleeding and infection [6]. In our study, as in other studies, skin thinning and ulceration were the most common reason for surgical intervention [7-10]. Cutaneous atrophy may lead to ulceration and associated catastrophic haemorrhage which requiring emergency ligation of the fistula [11]. By the reason of life threatening bleeding due to rupture, we had to ligature 4 (57.1%) of the fistulas that we had performed emergency surgery. But this rate remained

at 9.7% in elective cases and we saved 90.3% of the fistulas. In literature, we could not find fistula salvage rates in surgery for ruptured AVF compare with non-ruptured AVF aneurysms. In some of them, fistula preservation rates were given as 95% [12] and 88% [13] but elective and emergency surgery situation were not discriminated. For this reason, we think that our study will be useful for the literature. During skin thinning or ulceration stage AVF aneurysms is more inclined to bleeding. Rupture may become inevitable if this situation accompanied by an increase in the size of the aneurysm. In our study, the size of AVF aneurysms (68.6 ± 17.5 mm) which operated due to rupture was large as statistically significant ($p = 0.014$) (Table 1). NKF-DOQI guidelines state that intervention on a fistula should be performed in the presence of aneurysm formation and the aneurysmal segment should not be cannulated [3]. The treatment of focal fistula aneurysms has traditionally include resection of the aneurysm materials and interpositioning bypass by using prosthetic graft. Previously reported techniques for treatment of AFV pseudoaneurysms and aneurysms have included the use of self-expanding stent grafts [14], prosthetic graft exoprosthesis reinforcement [8], use of Tubularized CorMatrix [15], aneurysmorrhaphy [12], and partial aneurysmectomy with native reconstruction [9, 16] or prosthetic interposition [17]. Patel *et al*. [18], reported that they performed resection of the aneurysm, followed with graft interpositioning or primary repair and no fistulas were compromised or lost as a result of the procedure. Georgiadis *et al*. [19], in a study which they performed aneursym excision and graft interposition with PTFE graft, reported that patency rates of the repaired AVF as nearly 70%. Patency ratios of different techniques have been reported in previous studies. In our study, we performed aneurysm excision and repair with graft interposition in 25 (80.6%) patients and applied aneurysm plication in 6 (19.4%) patients. Cumulative primary AVF patency rates of our procedures was 77.8 %. Our patency rates are similar to the literature.

In this study, we focused on the management of AVF aneurysms.AVF aneurysm is definitely a condition to be treated. There are many surgical procedures and approaches in the literature. In all of these applications, it is important to ensure the patency of AVF. Timing of intervention is the most important point to maintaining the continuity of the fistula, according to us. Because, as we have seen, fistula rescue rates in ruptured AVF aneurysms are obviously less than in elective surgery. As a result of our study, we think that AVF preservation is at the second plan in the presence of life threatening bleeding in an aneurysm rupture.

Conclusions

In conclusion, consultation of these cases with a cardiovascular surgeon before they reach the rupture stage is an important condition for both the patency of the fistula and the vital risk of the patient. It is important to educate the hemodialysis team about fistula use and follow-up. Especially it should be explained that venous punctures applied to the same region may cause serious complications in the future and early surgical treatment may protect the fistula. This tells us that the surgeon, nephrologist and dialysis nurse should be in cooperate.

Informed consent

Written informed consent was obtained from the patients for publication of images.

Author Contributions

Consept-Design: KKÖ, USS; Data collection: NK, KKÖ, FT; Analysis: KKÖ, FT; Literature search: KKÖ, NK; Writing: KKÖ, USS, ŞY; Critical review: ŞY.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

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