Surgical Approaches to Symptomatic Arteriovenous Fistula Aneurysms: a Single-Center Experience

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Abstract

Arteriovenous fistulas (AVFs) created for hemodialysis accesses are prone to aneurysmal degeneration. Arteriovenous fistula aneurysms may lead to pain, aesthetic problems, infection, bleeding, and fistula thrombosis. The aim of this study is to report our surgical approaches and outcomes of AVF aneurysms. Medical records of a total of 21 patients (9 males, 12 females) with an AVF aneurysm who underwent surgery at Karabuk Training and Research Hospital, Department of Cardiovascular Surgery between January 2013 and March 2015 were retrospectively analyzed. The mean age was 59.7±13.5 years. Aneurysmectomy was performed on eight patients, while partial aneurysmectomy and polytetrafluoroethylene graft interposition were carried out in four patients. Three patients underwent aneurysmorrhaphy, whereas six patients underwent thrombectomy + aneurysmorrhaphy to the aneurysmatic segment. All patients were discharged without any event at the postoperative second day. They were scheduled for follow-up visits and assessed by Doppler ultrasound. Currently, surgical repair is the gold standard in the treatment of AVF aneurysms. Based on our experience, we recommend surgical interventions for selected patients to maintain AVF continuation.

Keywords: Arteriovenous fistula aneurysm, hemodialysis, vascular access

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Introduction

An arteriovenous fistula (AVF) is a vascular access method for hemodialysis in patients with end-stage renal disease with high patency and low complication rates [1]. According to the Registry of Nephrology, Dialysis and Transplantation in Turkey published by Turkish Society of Nephrology in 2013, 82.9% of a total of 52.675 patients on hemodialysis on a regular basis underwent hemodialysis through a native AVF [2]. Aneurysms due to the dilation of the venous veins are one of the non-thrombotic complications of AVF procedure, which can be also associated with an increased risk for pain, aesthetic problems, infection, bleeding, and fistula thrombosis [3]. In this study, we aimed to report our surgical approach to symptomatic AVF aneurysms based on our clinical experience.

Materials and Methods

Between January 2013 and March 2015, a total of 21 patients (9 males, 12 females) with a symptomatic AVF aneurysm which was related to an AVF for hemodialysis at Karabuk Training and Research Hospital, Department of Cardiovascular Surgery were retrospectively analyzed. Surgical indications were as follows: diameter larger than 30 mm and symptomatic aneurysms (skin ulceration, infection, caused high-output heart failure, AVF thrombosis). Any other disease including pseudo aneurysms and asymptomatic AVF-related aneurysms were excluded. All patients were assessed by physical examination findings. Arterial and venous structures were evaluated by color Doppler ultrasound. The surgical approach was selected based on the Doppler ultrasound findings.

Surgical technique: All surgical operations were performed under axillary block anesthesia. For aneurysm resection, local anesthesia with prilocaine was administered and proximal and distal segments of the aneurysmatic vein were ligated. In the following day, the skin was detached through the upper part of the thrombosed aneurysmatic segment and resection was carried out (Figure 1). For other surgical procedures, the thin layer which covered the aneurysm was detached and the proximal and distal brachial or radial arteries were hanged and the aneurysm sac was reached. The skin was incised through the mass and each aneurysm was checked to avoid misdiagnosis. In patients undergoing aneurysmatic segment plication, the diameter of the venous segments which was proximal and distal to the aneurysmatic segment was measured and plication was performed using 6/0 prolene sutures (Figure 2).

Partial aneurysmal resection and polytetrafluoroethylene (PTFE) graft interposition were performed for aneurysms which was located in the proximal of the venous segment of the arteriovenous anastomosis line. Following the resection of the aneurysmatic segment, PTFE graft interposition was used using 7/0 prolene sutures (Figure 3). Where necessary, a hemovac drain (Bicakcilar Tibbi Cihazlar Sanayi ve Ticaret A.S., Istanbul, Turkey) was placed into the aneurysmal bed and the folds were closed appropriately. The patients who were performed AVF-salvage surgery received a temporary dialysis catheter during the healing period of the revised segment of the AVF.

Figure 1. A resected segment of thrombosed arteriovenous fistula aneurysm after ligation

Figure 2. A plicated AVF aneurysm

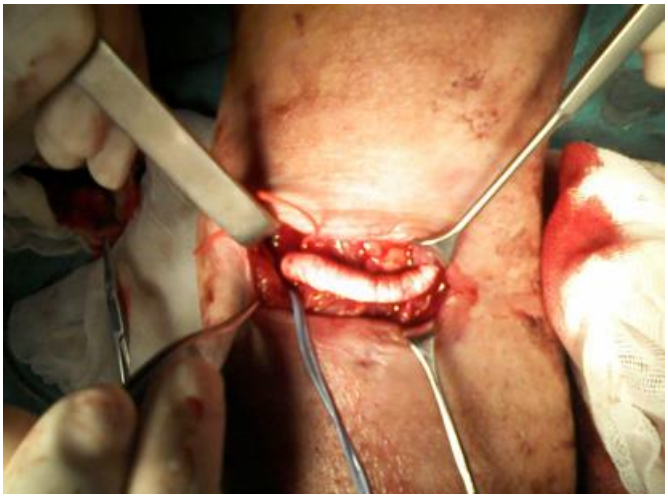

Figure 3. An AVF aneurysm partially resected, followed by PTFE graft interposition

Statistical analysis was performed using the SPSS for Windows version 15.0 (SPSS Inc. Chicago, IL, USA). Numeric variables were expressed in mean ± standard deviation.

Results

The mean age was 59.7±13.5 (range, 29-80) years. Of the patients, 12 (57%) were females. Demographic characteristics of the patients are shown in Table 1.

Table 1. Demographic characteristics of patients

Sex (n=21)	Male	9 (56%)
	Female	12 (57%)
Age (year)	59.7 ± 13.5	
Comorbidities	Hypertension	15 (71%)
	COPD	3 (14%)
	DM	12 (57%)
COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus		

Four aneurysmal fistulas were in radiocephalic, sixteen in brachiocephalic, and one in brachiobacillic nature. Aneurysmectomy was performed on eight patients, while partial aneurysmectomy and PTFE graft interposition were carried out in four patients. Three patients underwent aneurysmorrhaphy, whereas six patients underwent thrombectomy+ aneurysmorrhaphy to the aneurysmatic segment (Table 2). The mean diameter of all aneurysms was 47.6±9.9 mm (range, 37-67 mm).

All patients were discharged at the postoperative second day. None of patients experienced postoperative hemorrhagic or neurological complications. The mean follow-up was 12 (range, 11-13) months for patients who underwent aneurysmal plication. These patients who were followed clinically and through Doppler ultrasound are still on hemodialysis on a regular basis.

They were scheduled for follow-up visits and assessed by Doppler ultrasound. Currently, surgical repair is the gold standard in the treatment of AVF aneurysms. Based on our experience, we recommend surgical interventions for selected patients to maintain AVF continuation. The mean follow-up was 9.5±7.8 (range, 3-24) months for six patients undergoing thrombectomy + aneurysmorrhaphy. Thrombosis was reoccurred in three patients, while three patients are still on hemodialysis. The mean follow-up was 20.8±8.8 (range, 8-28)

months in patients undergoing partial aneurysmal resection and PTFE graft interposition. In all these patients, Doppler ultrasound findings were found to be normal and all are still on hemodialysis on a regular basis.

Table 2. Surgical interventions and indications

Internetions	**n (%)**	**Indications**
High-output AVF following renal transplantation	4 (19)	Aneurysm resection
Skin ulceration	4 (19)	Aneurysm resection in one patient and partial aneurysmectomy and PTFE graft interposition in three patients
High-output AVF-related heart failure	2 (9)	Aneurysm resection
Infection (*s.Epidermidis*)	1 (5)	Aneurysm resection
AVF thrombosis	7 (33)	Thrombectomy + aneurysmatic segment plication in six patients and aneurysmatic segment resection + PTFE graft interposition in one patient.
Saccular aneurysm	3 (14)	Aneurysmatic segment plication

Discussion

The creation of an AVF is the most optimal access for hemodialysis for patients with end-stage renal disease. One of the long-term complications of this procedure is AVF aneurysm [3]. If left untreated, these aneurysms may cause local compression-related symptoms, short-term complications including embolism, endocarditis and rupture, and long-term complications including venous hypertension and distal ischemia [3].

Long-term use of an AVF is of utmost importance for an effective hemodialysis. This can be attributed to the limited number of autogenous arteries and veins for the creation of an AVF. To date, two cannulation techniques have been described for vascular access, namely buttonhole and rope-ladder [4]. Short fistula length may complicate the procedure during the rope-ladder cannulation. On the other hand, despite the merits of the buttonhole technique such as easy cannulation and less pain, it is associated with a higher number of aneurysms and stenosis, as well as infections [5]. In the present study, the buttonhole technique for vascular access was performed in 17 patients who underwent hemodialysis.

The incidence of AVF-related venous aneurysms- pseudoaneurysms has been reported to be significantly higher compared to the inflow arterial aneurysms, which have been reported to

be 4 to 6% in the literature [6]. Although the arterial diameter increases in all inflow arteries, distal brachial arterial segment is the most affected due to the turbulences of the proximal bifurcation [5]. The incidence of inflow arterial aneurysms is higher in patients receiving immunosuppressive therapy and corticosteroids for renal transplantation [7]. In our study, six patients who were operated for AVF aneurysms had inflow arterial aneurysms of whom four underwent renal transplantation. In all patients with inflow arterial aneurysms, the aneurysm involved the brachial artery.

The surgical indications of AVF aneurysms include skin necrosis, the presence of an aneurysms-related obstructive kink, a thrombus causing to irregularity during dialysis, a high-output AVF, and treatment-refractory infection [8]. In the surgical treatment of AVF aneurysms, several methods such as ultrasound-guided compression, thrombin injection, aneurysm plication, ligation, and graft interposition can be used [9]. In a study including patients undergoing graft interposition following ligation, one-year patency rate was reported to be 70% [10]. In our study, aneurysm resection was performed in eight patients, partial resection combined with PTFE graft interposition of the resected segment in four patients, and aneurysmatic segment plication in nine patients. The proximal and distal of the aneurysmatic segment were ligated under local anesthesia in patients who were scheduled for aneurysm resection. In the following day, the thrombosed aneurysmatic segment was resected. Therefore, we attempted to reduce the thrombosed segment-related infection risk in patients with end-stage renal disease who may experience discomfort due to the thrombosed mass and are more prone to infections than healthy individuals [11]. In our facility, we often perform ligation, followed by resection in the next day to minimize postoperative bleeding and prevent thrombosed mass-related morbidity.

Furthermore, several approaches have been made for AVF aneurysms which were classified into four groups by Doppler ultrasound findings in the clinical setting [12]. According to the classification system, four of our patients had a type 1 aneurysm, which can be followed less often. In addition, one patient had a high-output AVF and three patients failed to receive dialysis due to the presence of a thrombus. In these patients, we performed partial resection, followed by PTFE graft interposition of the short segment. Thanks to the advantages of this technique, the PTFE graft was not required to be cannulated for native vein access for dialysis. None of the patients experienced failure during hemodialysis during the follow-up period.

On the other hand, although there are several studies suggesting that endovascular treatment is an effective treatment modality, it has some disadvantages such as high cost, foreign body-related infections, and the lack of long-term follow-up results [13,14].

We recognize that there are limitations to our study. The major limitation of our study is its retrospective design with a limited sample size. In addition, although the follow-up was available for all patients, the mean follow-up was only 9.5±7.8 months.

In conclusion, surgical repair is currently the gold standard in the treatment of AVF aneurysms. Based on our experience, we recommend surgical interventions for selected patients to maintain AVF continuation and avoid additional vascular interventions. In our opinion, it is essential that hemodialysis nurses must be trained to use the entire length of an AVF for puncturing (rope-ladder technique) to prevent an aneurysm formation.

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