

Our experiences with hemodialysis arteriovenous fistula aneurysm

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ABSTRACT

Objectives: This study presents the short-term clinical data of surgical treatment strategies of patients with hemodialysis arteriovenous fistula (AVF) aneurysms.

Patients and methods: Between January 2010 and July 2019, a total of 103 patients (69 males, 34 females; mean age 52.3±20.6 years; range, 18 to 87 years) who underwent elective AVF surgery due to AVF aneurysms (≥4 cm) were included in this retrospective study. Operative techniques and patients' outcomes were reviewed and analyzed.

Results: Aneurysm resection and graft interposition, ligation, and aneurysmorrhaphy (partial aneurysm resection and plication) were performed in 62, 5, and 14 patients with radiocephalic AVF aneurysms, respectively. Aneurysm resection and graft interposition, aneurysm ligation, and aneurysmorrhaphy were performed in 10, 7, and 5 patients with brachiocephalic and brachio basilic AVF aneurysms, respectively. Wound infection, hematoma, and seroma were seen as postoperative complications in 5, 4, and 11 patients, respectively. The mean postoperative fistula flow rate of the patients with brachiocephalic and brachio basilic AVFs was 402±48 mL/min. The mean postoperative fistula flow rate of the patients with radiocephalic AVFs was 325±69 mL/min. There was no in-hospital mortality.

Conclusion: It should be kept in mind that AVF aneurysms may cause serious consequences, if left untreated before the development of complications. The surgical treatment of AVF aneurysms not only reduces the risk for developing complications, but also provides the protection of the AVF in most patients.

Keywords: Aneurysm, arteriovenous fistula, hemodialysis, renal failure.

Late phase kidney failure is a chronic disease which results from the accumulation of metabolic effluents in the body.^[1] Chronic renal failure affects the entire body of the patient and untreated renal failure can be life-threatening. In these patients, if the renal transplantation cannot be applied, renal replacement treatment with hemodialysis or peritoneal dialysis is the second choice. Hemodialysis is preferred over peritoneal dialysis, since peritoneal dialysis has a higher infection risk.^[1] Arteriovenous fistula (AVF) is needed in the long-term for the hemodialysis treatment. In addition, AVF creation is still the most frequent and the most optimal method for hemodialysis patients.^[2] On the other hand, some complications of AVF which

include aneurysm formation may be seen in this period. In addition, aneurysm formation may occur due to repeated punctures for hemodialysis which can weaken the vein wall in selected patients.^[3] It is also known that AVF aneurysms can be associated with serious complications such as steal syndrome and heart failure, and surgical treatment of the aneurysm should be performed as soon as possible. Therefore, these patients should be followed closely. Surgical treatment is the gold standard for AVF aneurysms^[4]

In this study, we present the short-term clinical data of surgical treatment strategies of patients with hemodialysis AVF aneurysms.

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PATIENTS AND METHODS

Between January 2010 and July 2019, a total of 103 patients (69 males, 34 females; mean age 52.3 ± 20.6 years; range, 18 to 87 years) who underwent elective AVF surgery due to AVF aneurysms (≥ 4 cm) were included in this study. A detailed clinical history and physical examination were routinely performed in all patients as a part of preoperative assessment. Patients were also evaluated with Doppler ultrasonography before and on the first day of surgery. Main complaints of most of the patients were failure of hemodialysis treatment, palpable pulsatile mass, pain, and edema affecting the hands. Some of the patients had additionally lacerations, coldness of fingers, and numbness in the hand. All AVF aneurysms were located in the venous site of the AVFs.

The surgical method of the patients was determined by considering the arterial and venous structures of each patient individually. Operative techniques and patients' outcomes were reviewed and analyzed. Data were collected from the patient surgery records. A written informed consent was obtained from each patient. The study protocol was approved by the University of Health Sciences, Erzurum Regional Training and Research Hospital Ethics Committee. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Surgical techniques

The patient was taken to the operating room and prepped in the usual manner. Skin and subcutaneous

areas were anesthetized with local anesthesia. The aneurysm sac was controlled by proximal and distal of the brachial or radial arteries after 5,000 IU heparin was given for anticoagulation. An AVF aneurysm due to the puncture site in the forearm of the patient with radiocephalic AVF and hanging of the brachial artery for the control of the AVF flow are shown in Figure 1. The skin of the pulsatile mass was incised, and the subcutaneous tissue was passed. All AVF aneurysms were true aneurysms. Aneurysm resection and saphenous vein graft and/or synthetic graft interposition, ligation, and aneurysmorrhaphy (partial aneurysm resection and plication) were performed in 62, 5, and 14 patients with radiocephalic AVF aneurysms (AVF aneurysms were in the left arm in 68 and in the right arm in 13), respectively. A resected mass of the radiocephalic AVF aneurysm is shown in Figure 2 and synthetic graft interposition after the resection in the same patient is shown in Figure 3. Aneurysm resection and saphenous vein graft and/or synthetic graft interposition, aneurysm ligation, and aneurysmorrhaphy were performed in 10, 7, and 5 patients with brachiocephalic and brachio basilic AVF aneurysms (AVF aneurysms were in the left arm in 17 and in the right arm in five) respectively. Also, 10 and 12 patients had brachiocephalic and brachio basilic AVF aneurysms, respectively. A brachio basilic AVF aneurysm is shown in Figure 4 in another patient.



Figure 1. Control of the radiocephalic arteriovenous fistula aneurysm flow during surgical operation.



Figure 2. Resected of the mass of the radiocephalic arteriovenous fistula aneurysm.



Figure 3. Aneurysm resection and graft interposition of a patient with radiocephalic arteriovenous fistula aneurysm.



Figure 4. Brachiocephalic arteriovenous fistula aneurysm.

Surgical treatment of this AVF aneurysm is shown in Figures 5 and 6, respectively. Following the control of bleeding, the incision site was closed appropriately after placing a Penrose drain or a Hemovac drain (Bicakcilar, Istanbul, Turkey), if necessary. A



Figure 5. Resected of the mass of the brachiocephalic arteriovenous fistula aneurysm.



Figure 6. Aneurysm resection and graft interposition of the patient with brachiocephalic arteriovenous fistula aneurysm.

temporary hemodialysis catheter was placed in most of the patients who underwent repair of the AVF aneurysm. In some patients who underwent AVF ligation operation, AVF was performed in the other site and temporary hemodialysis catheter was placed. A permanent hemodialysis catheter was placed in five patients who underwent ligation of the brachial region AVF aneurysm. There was no other site for the AVF creation in these patients.

In this study, 81, 10, and 12 patients had radiocephalic, brachiocephalic, and brachiocephalic AVF aneurysms, respectively. When the AVF aneurysm is in the brachial region or forearm region, it does not affect the surgical intervention type of AVF aneurysm and the timing of the operation. The surgical intervention type was decided intraoperatively according to the absence or presence of proximal vein stenosis, residual diameter of AVF after the resection of AVF, the situation of arterial and venous structures, flow of AVF after the resection (partial or total excision of AVF aneurysm) of AVF aneurysm, and the diameter of prior and next segments of AVF aneurysm site.

Statistical analysis

Statistical analysis was performed using the SPSS for Windows version 13.0 software (SPSS Inc., Chicago, IL, USA). For continuous variables, the fitness to normal distribution and homogeneity were tested with the Kolmogorov-Smirnov test and the Levene test, and the data were classified accordingly. Continuous and categorical variables were expressed in mean \pm standard deviation (SD), median (min-max) or number and frequency. The independent samples t-test was used for parametric variables. A *p* value of <0.05 was considered statistically significant.

RESULTS

In the present study, patients with aneurysm resection and graft interposition or partial aneurysm resection and plication underwent hemodialysis treatment on the postoperative first day via their AVF. No neurological damage or ischemic complications were observed. After the surgical procedures, wound infection, hematoma, and seroma were seen as postoperative complications in 5, 4, and 11 patients, respectively. On the other hand, complaints of the patients improved after the surgical treatment. The mean pre- and postoperative fistula flow rates of the patients with brachiocephalic and brachio basilic AVFs were $1,402 \pm 308$ mL/min and 402 ± 48 mL/min, respectively. There was a statistically significant difference between the mean pre- and postoperative flow rates of these patients ($p=0.035$). Also, the mean pre- and postoperative fistula flow rates of the patients with radiocephalic AVFs were 997 ± 289 mL/min and 325 ± 69 mL/min, respectively. Also, there was statistically significant difference between these flow rates ($p=0.030$). Then, the patients without complication were discharged on the second day after surgery. There was no in-hospital mortality.

DISCUSSION

In patients with chronic renal failure who underwent hemodialysis treatment, AVFs are used as permanent vascular access points.^[5] On the other hand, renal transplantation is the primary treatment in patients with end-stage renal failure.^[6] However, hemodialysis is the first treatment of choice in this disease due to an increasing number of patients with renal failure, compared to the inadequate number of kidney donors.^[6] Moreover, native AVFs have certain advantages such as low complication, less intervention, and high patency rates. Therefore,

AVF creation is preferred as the first-line treatment modality in hemodialysis patients. Similarly, Odabasi et al.^[7] reported in their study that 90.1% of patients with chronic renal failure underwent hemodialysis via native AVF in Turkey. On the other hand, AVF has also some complications in the long-term. Rahman and Özsin^[8] reported in their study that late complications requiring revision of AVF complications were associated with not only increased morbidity and length of hospital stay, but also decreased quality of life and life span. They also emphasized that these complications could be reduced by appropriate surgical technique to establish AVF and proper hemodialysis access.^[8] One of the late complications of AVF is aneurysm development with an incidence rate of 5 to 8%.^[5,7] In patients undergoing hemodialysis, the origin of peripheral aneurysms are usually venous aneurysms. Terada et al.^[9] reported in their study that factors of the development of pseudo- or true-venous aneurysms were anastomotic technique errors, repeated injections, trauma to the entrance site, and infection. Furthermore, Shojaiepard et al.^[10] found that complications related to AVFs were encountered much more often in recent years due to the expanding population of this patient group.

On the other hand, an increased chronic cardiac volume load caused by AVF aneurysms can induce structural and functional cardiac changes and, then, cause left ventricular remodeling.^[11] Also, a high flow fistula is often tolerated and can sometimes cause heart failure, although it increases dialysis functionality. This is a particularly serious problem considering that cardiovascular disease is the leading cause of death in dialysis patient. Symptoms such as chest pain, paroxysmal dyspnea, and edema that may occur during rest, exertion or during dialysis with symptoms of heart failure may be present. Our patients had chest pain which was particularly present at the end of the dialysis and after the dialysis and dyspnea due to pulmonary edema prior to dialysis. Coronary angiography was performed in two patients due to severe chest pain and coronary arteries were evaluated as normal.

After the treatment of the aneurysm, the existing complaints regressed. Treatment of high flow fistula aneurysms in a short time would reduce unnecessary invasive procedures and mortality in patients. In our study, five patients had right heart failure which was detected with echocardiography in the preoperative period. Three of them had brachio basilic AVF aneurysms and two of them had brachiocephalic AVF aneurysms. These patients were improved after the

AVF aneurysm operation in the early postoperative period. Also, the mean postoperative flow rates of AVFs of all patients decreased statistically significant according to preoperative values. In three of our patients, there was severe ischemic pain toward the end of dialysis due to steal syndrome in the hand. Complaints completely resolved in these patients after aneurysm surgery. However, ischemia and necrosis developed at the second and third fingertips due to steal syndrome in one patient. Amputation was performed to the distal phalanges in this patient.

In advanced cases, true AVF aneurysms can cause multiple clinical conditions such as steal syndrome, cardiac abnormalities, embolization, thrombosis, skin erosion and infection, bleeding and compression of adjacent nerve structures, paresthesia, pain and decreased mobility, and this is why, when they are diagnosed, they should be treated quickly.^[11] Also, if bleeding occurs, hematoma, and anemia may develop. It is known that AVF aneurysm-related complications are improved by the closure of the aneurysm. We offer that surgery should be considered as a treatment option for the patients who have symptomatic AVF aneurysms before any complication develops. In addition, Hastaoglu et al.^[12] reported that surgical indications of AVF aneurysm are failure of hemodialysis via AVF, pain, skin erosion at AVF aneurysm site, and risk of rupture.

In this study, indications for surgical treatment of AVF aneurysm were increased diameter of AVF (≥ 4 cm), pain, failure of hemodialysis due to thrombosis of AVF aneurysm, and edema on their hands. Also, some patients additionally had skin lacerations, coldness of fingers, and numbness of the hand. Prompt surgical treatment of AVF aneurysms in these cases not only prevents these complications, but also provides hemodialysis access site for the patients.

Treatment methods of AVF aneurysms may be as manual compression under the color flow Doppler ultrasonography, ligation, endovascular graft implantation, embolization, ultrasound-guided thrombin injection and surgical reconstruction, although surgical repair is the most frequent and conventional treatment method.^[13] Furthermore, Parlar et al.^[6] reported that patients with AVF aneurysms should be operated in the early period before the development of any complications. Okten et al.^[14] emphasized that surgical treatment of the AVF aneurysm still remained gold standard. They also reported that due to the shortage of vascular access pathway, ensuring the continuity of the fistula

by narrowing the sac or the anastomosis instead of ligation can be used as an effective and safe surgical method in the short- and mid-term.^[14] Bachleda et al.^[15] also showed that traditional surgical treatment of aneurysm of the AVF involves either ligation or resection with prosthetic graft interpositioning.^[15] Also, they reported that surgical methods also included reduction aneurysmoplasty and ligation of the fistula was the least desirable option.^[15]

In this study, surgical techniques which were aneurysm resection and graft interposition and aneurysmorrhaphy were chosen to protect hemodialysis access facility. In addition, the most preferred surgical technique was aneurysm resection and graft interposition in this study. Figure 2 shows aneurysm resection and graft interposition of this patient. Aneurysmorrhaphy was used in this study as an another surgical procedure to protect the AVF in selected patients with an appropriate vein wall after the exploration. Hastaoglu et al.^[12] reported that aneurysmorrhaphy in the revisions of AVF aneurysm was a safe and satisfactory technique and should be adopted widely. Ligation was performed in patients who were not suitable for these repair techniques.

This study has some limitations. The main limitation is it's the small sample size. Also, it has a single-center, retrospective design. Third, the data on surgical results of AVF aneurysm are limited to the period of in-hospital stay of the patients.

In conclusion, it should be kept in mind that AVF aneurysms can cause serious consequences if left untreated before the development of complications. The surgical treatment of AVF aneurysms not only reduces the risk for developing complications, but also provides the protection of the AVF in most patients. Also, a detailed vascular examination of the patients and early surgical treatment are essential in this pathology.

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