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Original Article

Surgical interventions for arteriovenous fistula aneurysms: Our single-center experience

Arteriyovenöz fistül anevrizmalarında cerrahi girişimler: Tek merkez deneyimimiz

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ABSTRACT

Objectives: In this study, we aimed to evaluate the results of surgical treatment methods for arteriovenous fistula (AVF) aneurysms.

Patients and methods: A total of 29 patients (14 males, 15 females; mean age 67.4±13.4 years; range 28 to 73 years) who underwent surgical repair for late aneurysmal complications of AVFs at our center between January 2013 and September 2016 were retrospectively analyzed. Access route, aneurysm characteristics, anastomosis type, age of fistula, diameter of vein and artery, and access status were evaluated.

Results: All patients were treated for true or false aneurysmal complications. Different techniques according to the complications were used; however, the most common method was ligation and excision with a rate of 96.5% (n=28). No significant complications during or after the procedure occurred and no mortality was seen at one month. Minor complications occurred in two patients with small hematomas. The median follow-up was 28 (range, 3 to 41) months.

Conclusion: Aneurysms are common and often difficult complications seen with arteriovenous vascular access for hemodialysis. Aneurysms can be managed either with conventional surgery or with endovascular techniques.

Keywords: Arteriovenous fistula; arteriovenous fistula aneurysm; vascular access complication.

ÖZ

Amaç: Bu çalışmada, arteriyovenöz fistül (AVF) anevrizmalarında uygulanan cerrahi tedavi yöntemlerinin sonuçları değerlendirildi.

Hastalar ve Yöntemler: Ocak 2013 - Eylül 2016 tarihleri arasında merkezimizde geç dönem AVF anevrizmal komplikasyonlarının cerrahi tamiri yapılan toplam 29 hasta (14 erkek, 15 kadın; ort. yaş 67.4±13.4 yıl; dağılım 28-73 yıl) retrospektif olarak değerlendirildi. Girişim yolu ve anevrizmanın özelikleri, anastomoz tipi, fistül yaşı, ven ve arter çapı ve girişim durumu değerlendirildi.

Bulgular: Hastaların tümü gerçek ve yalancı anevrizmal komplikasyonlar nedeniyle tedavi edildi. Komplikasyonlara göre farklı teknikler kullanıldı; ancak en sık kullanılan yöntem %96.5 (n=28) oranı ile ligasyon ve eksizyon idi. İşlem sırası ve sonrasında önemli bir komplikasyon görülmedi ve birinci ayda mortalite izlenmedi. İki hastada minör komplikasyon olarak küçük hematom görüldü. Ortalama takip süresi 28 (dağılım: 3-41) ay idi.

Sonuç: Anevrizmalar hemodiyaliz için oluşturulan arteriyovenöz vasküler erişimlerde sık görülen ve genellikle zorlu komplikasyonlardır. Anevrizmalar konvansiyonel cerrahi veya endovasküler teknikler ile tedavi edilebilmektedir.

Anahtar sözcükler: Arteriyovenöz fistül; arteriyovenöz fistül anevrizması; vasküler girişim komplikasyonları.

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Survival rates in patients with end-stage renal disease have been increasing owing to the developments in treatment procedures; therefore, the importance of sustained vascular access for hemodialysis has increased far away.[1]

Many late complications, such as thrombosis, venous hypertension, aneurysm/pseudoaneurysm formation, hemorrhage, vascular steal syndrome, stenosis, and heart failure may occur following arteriovenous fistula (AVF) surgery.[2] These may cause dysfunction of the AVF and limit the efficiency of hemodialysis. Therefore, successful surgical outcomes have become more of an issue. However, the complications of AVF aneurysms may result in severe life-threatening events, such as rupture, bleeding or vascular access dysfunction, and thrombosis.

In the present study, we aimed to evaluate the results of surgical treatment methods for AVF aneurysms.

PATIENTS AND METHODS

This retrospective study included a total of 29 patients (14 males, 15 females; mean age 67.4±13.4 years; range 28 to 73 years) who underwent surgical repair for late aneurysmal complications of AVFs at our center between January 2013 and September 2016.

The study protocol was approved by the Ankara University School of Medicine. The study was conducted in accordance with the principles of the Declaration of Helsinki.

In running fistulas, the patients were initially referred to endovascular treatment options before a surgical intervention. In case of bleeding, arterial embolization and the preference of patient, surgical procedures were performed regardless of AVF functions. In patients with dysfunctional AVF, all patients were referred to surgical excision and creation of new access. Data of all patients, including preoperative demographic features, surgical techniques, and postoperative outcomes, were collected and analyzed for this study.

Patient demographic data included age, sex, hypertension, diabetes mellitus, coronary artery disease, congestive cardiac failure, tobacco use, arrhythmia, hypercholesterolemia, obesity, and recent renal transplantation (Table 1).

In our hospital, all patients are firstly evaluated at nephrology department and referred to our center for AVF aneurysms. After this initial assessment, the patients with a running aneurysmal AVF are referred to the interventional radiology department. Selected patients are subjected to the initial procedures in which various endovascular methods are applied for terminating the AVF. The patients who are admitted in critical conditions (rupture, bleeding) or in whom the endovascular options fail are referred to a surgical procedure for AVF aneurysms. In the present study, we only included the patients for whom surgical interventions were absolutely necessary.

The initial diagnosis of a true or false aneurysm with its pulsating mass effect was usually made easily through physical examination (Figure 1). The preoperative clinical evaluation included a color Duplex Doppler ultrasound (CDDUS). If there was a suggestion of central stenosis, a fistulogram was

Table 1. Demographic features of patients

Variable	n	%	Mean±SD
Age (year)			67.4±13.4
Gender			
Males	14	48.2	
Hypertension	17	58.6	
Diabetes mellitus	14	48.2	
Coronary artery disease	8	27.5	
Congestive cardiac failure	3	10.3	
Arrhythmia	4	13.7	
Tobacco use	5	17.2	
Hypercholesterolemia	9	31	
Obesity*	4	13.7	
Recent renal transplantation	1	3.4	

SD: Standard deviation; * Obese patients with a body mass index of 30.0 to 39.9 kg/m^2, or severely or morbidly obese patients with a body mass index of >40.0 kg/m^2 or higher.

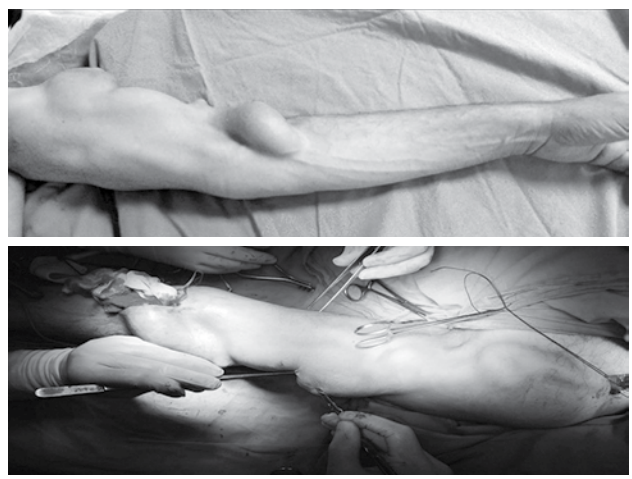

Figure 1. Typical appearance of radio-cephalic arteriovenous fistula aneurysm. The dilated cephalic vein is distended irregularly along its serpentine way and other draining veins are similar.

performed for further evaluation. The exact AVF anatomic pathology and aneurysm characteristics, including diameter, length, thrombus presence, and stenosis area in the aneurysm were measured preoperatively by CDDUS. Proximal or distal stenotic lesions along with an enlarging aneurysm were also preoperatively detected by ultrasound imaging. This preoperative protocol was carried out on all patients in our study group. According to our preoperative assessments, one of them had patency, and the others were non-functional for hemodialysis.

Surgical method details

As mentioned above in the study, our aim was fundamentally to get through severe complications of failed aneurysmal AVFs. The best timing for surgical correction of each failing access was considered to be one day after a hemodialysis session. Prophylactic intravenous antibiotics were administered two hours before each procedure, independent of the type of correction applied. We administered local anesthesia in all revision surgery operations, which was considered sufficient.

Our primary general strategy was not to salvage the AVF, as severe complications such as life-threatening bleeding, severe ischemia, infection, or ulcerations required the closure of the access and, thus, none of them were functional and efficient for hemodialysis before and after the intervention. In the rest, a new AVF was created during the same session or had already been created before on the other side.

Table 2. Surgical details

Access and aneurysm characteristics	n	%	Mean±SD
Arteriovenous fistula type			
Brescia-Cimino	13	44.8	
Brachial artery-cephalic vein	12	41.3	
Brachial artery-basilic vein transposition	3	10.3	
Femoral artery-saphenous vein loop	1	3.4	
Anastomosis type			
End-side	27	93.1	
Side-side	2	6.89	
Age of fistula (months)			41.5±28.2
Access vein diameter (cm)			4.1±0.1
Access artery diameter (cm)			2.9±1.5
Access status			
Failed	28	96.5	
Running	1	3.4	
Skin fistulization/bleeding at admission	1	3.4	
Thrombus within aneurysm	5	17.2	
Intimal hyperplasia at anastomosis site	13	44.8	
Type of aneurysm			
True	10	34.4	
False	19	65.5	
Surgical technique			
Coil embolization + excision	1	3.4	
Ligation + excision	28	96.5	
Graft interposition	1	3.4	
Vein	0		
Artery	1	3.4	

SD: Standard deviation.

Access and aneurysm characteristics, anastomosis types, age of fistula, access vein and artery diameter, access status are listed in Table 2. Ligation and excision was the mostly used procedure in our study population (Figure 2). Proximal and distal segments of artery at anastomosis site and the aneurysmal portion of vein were completely exposed. Then, AVF was occluded by suturing of aneurysm neck. The source artery was clamped proximally and distally to anastomosis site. After the aneurysmal vein segment was excised, the artery was repaired via primary or patchplasty techniques. Internal jugular vein or axillar vein accesses were used for endovascular coil embolization. In patients who had both AVF and source artery aneurysm, aneurysmal portion of the artery was also excised with an aneurysmal fistula and a graft interposition procedure was used with end-to-end anastomosis technique (Figure 3). We did not use wrapping or banding techniques for AVF aneurysms due to poor long-term results.

Patients were examined for the first time one month after discharge and within six to 12 months with periodical clinical examination.

Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 16.0 software (SPSS Inc., Chicago, IL, USA). Continuous variables were presented in mean ± standard deviation (SD) or median (min-max). Categorical variables were expressed in numbers and percentages. A p value of 0.005 was considered statistically significant.

RESULTS

During the study period, 29 patients were treated for true or false aneurysmal complications. The demographic data and systemic comorbidities are shown in Table 1. The median follow-up duration for the study population was 28 (range, 3 to 41) months.

The initial complicated AVF aneurysms comprised 13 radiocephalic fistulas, 12 brachiocephalic fistulas,

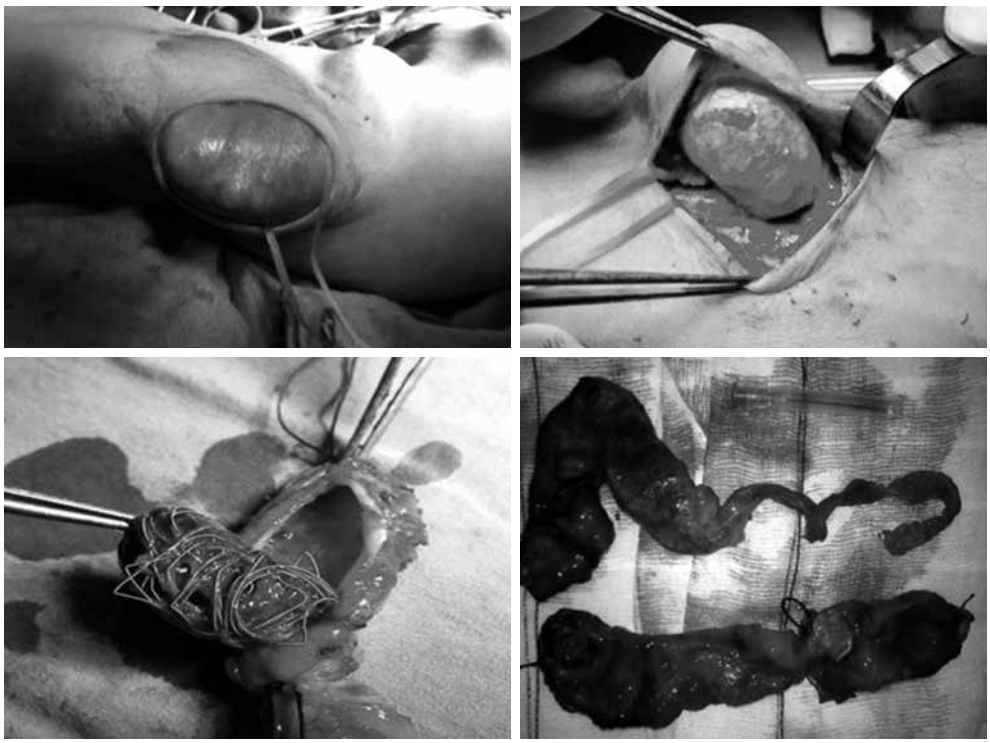

Figure 2. Arteriovenous fistula pseudoaneurysm. Initially, it was treated with radiological coil embolization method and then surgically ligated and excised.

Figure 3. End-to-end graft interposition due to concomitant brachial arterial aneurysm.

three basilic vein transposition fistulas, and one femoral artery and saphenous vein loop fistulas of which 28 of them failed and one had running at presentation.

One of the patients (3.4%) had bleeding due to skin fistulization on admission and underwent an emergent operation. We performed ligation and excision technique in this case. Five patients (17.2%) had a thrombus within the aneurysm, while 13 patients (44.8%) had intimal hyperplasia at the anastomosis site. Ten patients (34.4%) with AVF aneurysms had a true aneurysm and 19 (65.5%) had a false aneurysm.

We performed different techniques according to complications. The most common method was ligation and excision with a rate of 96.5% (n=28). Endovascular coil embolization was preferred in a patient who had a running aneurysmal AVF; however, this patient underwent a following surgical excision procedure due to severe pain and worse cosmetic result.

The complications in AVFs performed in the Brescia-Cimino region were more common, as the most performed AVF type was Brescia-Cimino in our department. In addition, the surgical procedures performed for each complication type are summarized in Table 2.

Following the operations, we classified aneurysms as true or false and 10 of them (34.4%) were true, 19 (65.5%) were false aneurysms. One of the patients had brachial arterial ectasia, and required no intervention; however, one had a concomitant arterial aneurysm and we performed end-to-end graft interposition as shown in Figure 2.

No significant complications occurred and no mortality was seen at one month during follow-up Minor complications occurred in two patients with small hematomas.

DISCUSSION

Complications of vascular access (VA) are common and represent a major cause of hospitalization in hemodialysis patients with 36 to 39% of admissions related to dialysis access.[3] Of many complications which may threaten the longevity of VA, aneurysms represent a significant challenge which threatens the both the AVF and the patient. The incidence of aneurysms is highly variable ranging from 5 to more than 60%, as there is no standardized definition and systematically review in the literature.[4-6]

The etiology of aneurysms has not been well-defined in the literature. Pseudoaneurysms may be from the anastomosis and reflect leaking of blood outside the lumen perioperatively as a result of surgical technique or occur later as a complication of infection.[7] Puncture of an AVF or arteriovenous graft (AVG), either as a part of standard dialysis needling or from intervention, may also result in prolonged bleeding and pseudoaneurysm formation.[7] True aneurysms may be more difficult to define. The artery proximal to an AVF routinely dilates, as it remodels in response to the increased blood flow.[8] The vein of an AVF typically increases in diameter greater than three-fold to mature enough for needling. Most autologous in situ AVFs are often irregular and dilate asymmetrically.

The etiology of true aneurysms in AVFs is less clear. Repeated needling results in multiple small fibrous scars in the vessel wall, which may expand with time and result in localized aneurysmal areas.[9]

Although arterial aneurysms are rare, they are significant complications after a long-term creation of hemodialysis access. High-flow and immunosuppression may accelerate this process.[10] In our study, two of our patients had arterial ectasia and aneurysms.

The underlying mechanism is still unclear, although probably the increase in arterial flow following AVF produces an increase in wall stress and a decrease in wall thickness.[11] These changes upregulate the local production of vasodilator agents (nitric oxide) and matrix metalloproteinases 2 and 9, which are also associated with adaptive arterial remodeling by the internal elastic lamina fragmentation and arterial enlargement.[12,13]

Many patients may undergo dialysis for years without any problem on large and tortuous AVFs which would be classified as aneurysms. These stable aneurysms can be observed clinically and through ultrasound. Surgical indications are based on the clinical concerns which threaten the patient's life and treatment process. Clinical concerns are raised, when an aneurysm presents with a rapid increase in size, pain, thinning and degeneration of the overlying skin and/or infection. This situation can lead to a rupture subcutaneously or a free rupture through the skin.[14]

If an aneurysm has ruptured or there is a risk of imminent rupture (skin ulceration and scab/infection),

emergency ligation of the aneurysm is required. In less-emergent situations, the indications for surgery are not defined. A growth of >10% per year increases the risk of rupture. Skin thinning and shiny atrophic skin are indicators for intervention.[15] Aesthetic reasons and also in high-flow situations possibly require treatment in certain patients.

The options for treatment are surgical or radiological. Endovascular techniques either alone or combined with surgery have been used to treat AVF aneurysms; however, cosmetic results of surgical procedures are still better.[16]

In conclusion, repetitious needle puncture with anticoagulation and unstable hemodynamics make pseudoaneurysms and true aneurysms relatively usual complication in patients with AVFs. Although exact definition and limited classification in the literature inhibits to improve the most optimal management, the main treatment strategy should be preventing life-threatening complications, predict the best timing of intervention, and confirm the optimum modality.

Declaration of conflicting interests

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