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AN EVALUATION OF DISTAL RADIOCEPHALIC SIDE-TO-SIDE ANASTOMOSIS PERFORMED FOR HEMODIALYSIS IN PATIENTS WITH END-STAGE CHRONIC RENAL FAILURE

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Abstract

Aim: In our study we evaluate the early and late term patency ratio, time to maturation and fistula associated complication rates in cases with an arteriovenous fistula (AVF) created via a distal radiocephalic side-to-side anastomosis without ligation of distal cephalic vein in patients with end-stage renal failure (ESRF) and suggest that the fistulae complications can be diagnosed and treated with simpler and minimally invasive methods.

Methods: The demographic data, outpatient clinic follow-up records on day 1, week 1, month 1 and year 1, fistula-related complications and treatments given for complications of patients were evaluated.

Results: Of the 50 operated patients, five (10%) developed fistula thrombosis on postoperative day 1 and underwent thrombectomy with a Fogarty catheter inserted via the distal cephalic vein; the fistula remained active after thrombectomy in two patients. Of the 47 patients followed at Month 1, 37 had a functional fistula and two had a functional fistula following thrombectomy. The early-term primary and secondary patency ratio was 78.7% and 82.9%, respectively. Of the 45 patients who attended the 1-year follow-up, 33(76.7%) had a non-intervened fistula, and with the addition of the two patients who underwent early-term thrombectomy, 35(81.3%) patients in total had fully functional fistulae. The one-year primary and secondary patency ratio was 76.7% and 81.3%, respectively. None of the patients developed such complications as venous hypertension or distal ischemia.

Conclusions: Arteriovenous fistula created via distal radiocephalic side-to-side anastomosis without ligation of distal cephalic vein can be successfully used as a vascular access in patients with ESRF.

Keywords: *End stage renal failure, hemodialysis, arteriovenous fistula, complication, side-to-side anastomosis*

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Introduction

The renal replacement therapies given to patients with end-stage renal failure (ESRF) include hemodialysis, peritoneal dialysis and kidney transplant[1]. Hemodialysis is mainly given via autogenous arteriovenous fistulae, shunts made from synthetic materials and central venous catheters[2]. The most appropriate venous access route for hemodialysis is via an autogenous arteriovenous fistula, being an approach that is associated with decreased complications and minimal negative effects on quality of life[3].Almost half of the patients undergoing hemodialysis are older than 65 years, and this ratio is increasing, and more than 70% of this patient population has other chronic diseases (comorbidities) accompanying end-stage renal failure. Fistulas may be decided against, may have delayed maturation or may become problematic due to vascular deformities and inadequacies, and morbidity and mortality due to comorbidities can be high in these patients. Accordingly, there have been several studies in literature recommending the establishment of intravenous access via a proximal arteriovenous fistula rather than a distal arteriovenous fistula, or the use of synthetic grafts in this patient group[4-7].

Among the arteriovenous fistulae, the most appropriate are distal radiocephalic arteriovenous fistulae, which are formed through the anastomosis of the radial artery and cephalic vein at the level of the wrist with a correct timing. Distal radiocephalic fistulae are generally created side-edges with keeping the edge of vein to the side of artery, although there are also reports describing artery-edge, vein-side, or artery and vein edge-to-edge anastomosis[8]. Another method involves the connection of the distal vein after side-to-side anastomosis. Vein-edge artery-side anastomosis, or the ligation of the distal vein after side-to-side anastomosis is the most frequently recommended approach and is applied in almost all cases. This is due mostly to the risk of development of such complications as venous hypertension, particularly in the first finger, or delayed maturation of the actual fistula connecting to the heart, as the fistula may work towards the distal[9].

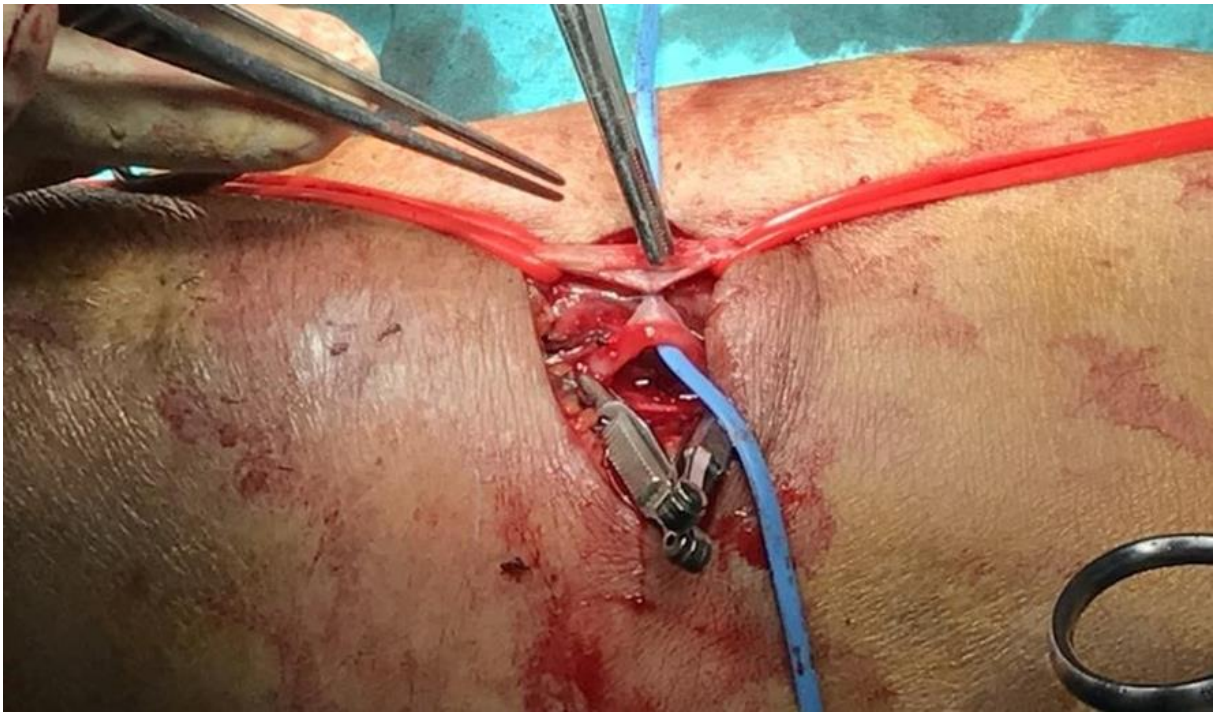

Figure 1. Creation of distal radiocephalic AVF

We believe that leaving the distal vein open will not cause any problems, and may in fact help the fistula work more efficiently, and hypothesize that the diagnosis and treatment of problems may be easier given the opportunity to enter radiologically from the open end. In the present study we evaluate the benefits of prospectively planned fistulae created by distal radiocephalic side-to-side anastomosis without ligation to the distal vein.

Materials and Methods

After gaining the approval of the ethics committee (2017/324), patients who underwent distal radiocephalic side-to-side anastomosis between June 2012 and December 2015 in the Peripheral Vascular Surgery Unit of the General Surgery Department of Istanbul University Faculty of Medicine were included in the study. Included in the study were patients with end-stage renal failure, with no previous AVF, with no central venous catheter (CVC) on the same side and no history of CVC intervention, and with the cephalic vein distal left open after radiocephalic side-to-side anastomosis. All participants were operated on by the same surgical team, and none had conditions that may increase the tendency of thrombophilia or bleeding.

All patients were checked against the inclusion/exclusion criteria, and those who did not meet these criteria were excluded from the study. In total, 50 patients with end-stage renal failure who underwent distal radiocephalic side-to-side anastomosis were included in the study, and all provided informed consent for their inclusion.

Patient data including sex, age, chronic renal failure (CRF) etiology, use of hemodialysis at the time of operation, type of intravenous access if receiving hemodialysis, vein and artery characteristics noted during the operation, fistula status on Day 1, Month 1 and Year 1, the time until fistula was used after creation (maturation time) were investigated. The fistula was preferably created in the non-dominant arm or in the upper extremity that had not previously undergone any major arterial or venous intervention (hemodialysis catheter, pacemaker, angiography, arteriovenous fistula history, trauma etc.). A distal radiocephalic side-to-side arteriovenous fistula was formed on left and right upper extremity of 44 and six patients, respectively.

Figure 2. Dilation of the spasm of AVF with Fogarty catheter

Distal pulses were palpated, arterial blood pressure measurements were obtained for both arms, and upper extremity surgery or catheter insertion histories were questioned during the preoperative physical examination.

The differences between the upper extremities upon inspection and palpation, venous return disturbances, finger and toe perfusion, and capillary filling duration were evaluated, and an Allen test was performed.

All patients were operated by the same surgical team to avoid issues related to differences in surgical techniques. The patients were given no postoperative anticoagulant or antiaggregant therapies other than their concomitant medications.

Surgical Technique

Local anesthesia was induced via a 5cc 2% lidocain injection approximately 1 cm lateral to the radial artery cleft and 4–5 cm proximal to the wrist curve, and 3–5 cm longitudinal cuts were made. The cephalic vein and radial artery were dissected and the distal and proximal parts of the artery were clamped, the distal and proximal parts of the vein were looped (silastic vein stripes), and an 8–10 mm longitudinal arteriotomy and venotomy were performed. A side-to-side radiocephalic arteriovenous fistula was formed with a single-layer continuous suture, using 7/0 polipropilene, starting bilaterally from the middle of the posterior walls of the vein and artery (Figure 1). Following anastomosis, the presence of thrill on fistula palpitation was assessed and bleeding was controlled. The skin was closed by single layer 5/0 prolene or skin stapler. The presence of thrill was checked by postoperative palpation and murmurs were examined via auscultation. In the event of a nonfunctional fistula, a 1–2 mm venotomy was performed from the cephalic vein distal which was left open and a 3F or 4F Fogarty catheter was inserted to the proximal of the artery and/or vein, inflated and retracted, with the aim being to eliminate spasm (Figure 2). A thrombectomy was performed if a thrombus developed.

Fistula thrill and murmur examination were performed via palpation and auscultation in all patients on postoperative Hour 1 and Day 1 in the clinics, and on Week 1 and Month 1 in the outpatient clinics. Outpatient clinic examinations were conducted at months 3, 6, 9 and 12. It was learnt from the patients' relatives that seven patients died to comorbidities during follow-up. All patients were questioned for the presence of pain, color change, and generalized or localized oedema in the distal fistula, palmar region, hand dorsum or fingers, as well as long-term muscle atrophy, ulceration and dry or wet gangrene formation in the hand and fingers. If such symptoms were present, detailed questions were asked to evaluate if they were persistent, and whether they developed during rest or hemodialysis.

Statistical evaluation

The results obtained in the study were assessed using Microsoft Excel 2011 and the statistical analyses were conducted using SPSS for Windows (Version 16.0. Chicago, SPSS Inc.). The study data were presented as mean +/- standard deviation and minimum-maximum.

Results

A total of 50 patients were included to the study, of which 40% were female and the mean age was 59.49±16.42 years (15–94). After being diagnosed with chronic renal failure, the mean follow-up duration was 55.03±47.61 (1–120) months. The most common etiology for chronic renal failure was diabetes mellitus, reported in 15 patients (30%), followed by hypertension in 14 (%28), and 14 (28%) patients were receiving hemodialysis, all via the venous catheter access route. The localization of the catheter among the patients receiving hemodialysis was the subclavian vein in three (21.4%) cases and the internal jugular vein in 11 (78.6%) cases, and the mean duration of hemodialysis was 1.77±1.03 months (1–3 months). An arteriovenous fistula was formed on the right and left arm of six (12%) and 44 (88.2%) patients, respectively. Of the

six patients with an AVF in the right arm, the right upper extremity was used for the AVF in four as there as left jugular hemodialysis catheter and in 2 as it was the non-dominant side. Of the 44 patients whose left-upper extremity was used for the AVF, this side was selected due to the presence of a hemodialysis catheter in 10 (7 right jugular, 3 right subclavian), and as the non-dominant side in the remaining 34 patients. Table 1 represents demographical and clinical data.

Postoperative Period

In the patient controls on postoperative Day 1, five (10%) patients had a dysfunctional fistula and a primary opening ratio of 90%. These patients underwent thrombectomy with the insertion of a Fogarty catheter via the distal cephalic vein. The fistula was functional and mature after thrombectomy in two patients, and the fistula again stopped functioning in postoperative Week 3 in one patient. In one patient, the fistula was thrombosed again during the early-term after thrombectomy. Basilic vein transposition was performed in one patient whose fistula was re-thrombosed after the thrombectomy. Furthermore, three patients were excluded from the study after not attending early-term follow-ups. Five patients developed dysfunctional fistula in the early term, and another patient was not intervened due to poor overall general condition. In four of the patients with dysfunctional fistula, vascular structural disturbances were seen perioperatively during the initial surgery and underwent more proximal AVFs (Gracz in on patient, brachiocephalic in 3 patients) without thrombectomy.

Of the 47 patients who attended postoperative early-term follow-up visits, 37 (78.7%) had functional fistula. The early term primary patency ratio was 78.7%. The fistula became functional after thrombectomy in two patients.

Table 1. Demographic and clinical data

				n:50
Age mean+std (min-max)				59.49±16.42 (15–94)
Gender	Men			30 (60)
	Women			20 (40)
Chronic renal failure etiology	Diabetes mellitus			15 (30)
	Hypertension			14 (28)
	Nephritis			7(14)
	Urological causes (congenital growth impairment, postrenal causes, nephrectomy due to kidney tumor, etc.)			7(14)
	Amyloidosis			3 (6)
	Idiopathic nephropathy			4 (8)
Duration of follow-up after chronic renal failure diagnosis (months)				55.03±47.61 (1–120)
Duration of hemodialysis (years)				1.77±1.03 (1–3)
Side	Right	Non-dominant	4	6
		Opposite side dialysis catheter	2	
	Left	Non- dominant	34	44
		Opposite side dialysis catheter	10	

Table 2. Clinical characteristics and rates of use for AVF

Postoperative day 1 (n:50)	Postoperative patency	45 (90)
	Thrombectomy	5 (10)
First month follow-up (n:47)	Primary patency	37 (78.7)
	Secondary patency	39 (82.9)
First year follow up (n:45)	Primary patency	33 (76.7)
	Secondary patency	35 (81.3)
The need of AVF use for hemodialysis (n:39)	1st month	22
	1st year	7
Venous hypertension		0
Steal syndrome (Ischemia)		0

The secondary patency ratio was 82.9%. Of the 39 patients with functional fistulae, 22 (56.4%) were started on hemodialysis via the fistula in postoperative Month 1. Among the remaining 17 patients with functional fistulae, seven developed a need for dialysis after 1 year and hemodialysis was initiated through the fistula.

Two patients did not return for 1 year follow-up and were excluded from the results. Of the total seven (15.5%) patients who died to comorbidities during follow-up, including two within the first year, one (14.2%) never needed dialysis. Two patients who died within the first one year were excluded from the follow-up. By the end of the one-year follow-up, two patients had undergone early-term thrombectomy and 33 patients' fistulae were functioning without intervention (1st year primary potency ratio 76.7%), totaling 35 patients (1st year secondary potency ratio 81.3%). None of the patients developed venous hypertension or distal ischemia during the one-year follow-up. The clinical characteristics and rates of use of AVF are presented in Table 2.

Discussion

We present here an evaluation of arteriovenous fistula formed by distal radiocephalic side-to-side anastomosis without connecting to the distal vein as a venous access route in patients receiving or planned for hemodialysis as a renal replacement therapy for end-stage renal failure. The aim in this regard is to demonstrate its ease of use for hemodialysis, for the determination of complications and complication rates, and to show that potential comorbidities can be managed by invasive imaging with decreased mortality by allowing concurrent radiological interventions.

One of the most common problems encountered is the failure of arteriovenous fistula to mature sufficiently to allow dialysis, with previous studies reporting rates varying between 18% and 53%[10]. There are two main problems that may need to be addressed, being early thrombosis and lack of maturation (the fistula works, but flow is insufficient to allow hemodialysis).

In a large-scale study conducted in 2016, proximal fistulae were evaluated in 602 patients and a rate of 5.3% was reported[10]. In this study, five patients developed fistula thrombosis within the first 24 hours (10%), and while this rate may seem high at first, our patient group was older (mean 59.49), and AVF was performed in all patients, without differentiation. In the aforementioned study, the risk of obstruction in distal compared to proximal ones (Brachiocephalic and brachiobacilik) was found to be (OR) 2.76, and so the rate of early obstruction in the present study was even lower than in the earlier study. Globally, the leading approach to the management of early obstructed fistulas is to open a new AVF in a new region, and at more proximal location on the same arm if possible, before referring to another rescue intervention.

In a meta-analysis conducted in 2004 comparing the patency rates of radiocephalic AVFs, it was shown that the postoperative primary failure, 1st month and 1st year primary patency rates differed from study to study, while the rates observed in the present study are consistent with literature[11].

In a study performed in 2016, Park SC et al.[12] reported a maturation failure rate of 32.6% among patients who underwent radiocephalic AVF, and ensured fistula maturation through proximal balloon angioplasty. In a literature review published in 2013, Tordoir JH et al.[13,14] reported the studies that increased fistula potency via using peri- or post-operative surgical or endovascular methods in patients with AVF. In the present study, fistulae that were thrombosed postoperatively and the developed obstruction were intervened with fistulography via the distal cephalic vein, which was left open, allowing radiological thrombectomy or balloon dilatation to be performed in the same session if needed.

AVFs opened using the balloon assisted maturation (BAM) technique can develop such complications as spasms, hematoma, rupture and thrombosis[15]. In the present study, complications developing at the puncture site cannot lead to problems in the fistula as there is no connection to the distal cephalic vein.

The frequency of venous distal hypertension was not as high as expected, occurring in no patient in the present study. In the event of venous hypertension development, the cephalic distal vein can be easily connected through a new incision made over the former one, without requiring further interventions to the fistula. Not connecting the distal cephalic vein has no negative impact on the maturation of the fistula or the duration of potency. Leaving the cephalic vein open also allows the management of spasms that may occur through the insertion of a Fogarty catheter through the distal vein, or by performing a thrombectomy should thrombosis develop.

Conclusion

Arteriovenous fistula created via distal radiocephalic side-to-side anastomosis without ligation of the distal cephalic vein can be considered a viable intravenous access route in patients with end-stage renal failure who are receiving or are planned to receive hemodialysis. We therefore prefer to open arteriovenous fistulae via distal radiocephalic side-to-side anastomosis in patients with end-stage renal failure who are referred to our clinics for the establishment of arteriovenous fistula as a venous access route.

Conflict of interest
The authors declare that they have no conflict of interest.

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Ethical approval
The Clinical Research Ethics Committee approved Istanbul University Faculty of Medicine (date:2017, number:413).

Authors Contributions
Collection of the data, writing of the article, draft: Sercan Yuksel.
Critical review of the article, writing of the article, performed the analysis: Fatih Yanar.
Critical review of the article, design of the study, review of the literature: Selcuk Baktiroglu

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