Original Article

Comparison of Complications of Arteriovenous Fistula with Permanent Catheter in Hemodialysis Patients: A Six-month Follow-up

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Abstract

Background: Arteriovenous fistula (AVF), permanent catheter (PC), and vascular graft are three vascular access types used for hemodialysis procedure. Due to insufficient reliable information on the comparison between AVF and PC, this study was conducted to compare AVF and PC regarding dialysis adequacy. **Materials and Methods:** This prospective study was carried out from March, 2013 to September, 2013. In this study, 76 hemodialysis patients were enrolled and assigned to two unequal groups of AVF and PC. Before and after the dialysis session, blood samples were taken for laboratory examinations and measurement of urea reduction ratio (URR) and Kt/V. The patients were followed up for six months, and then laboratory examinations were repeated. **Results:** Of the 76 hemodialysis patients, 30 had AVF and others PC. During the 6-month follow-up, 24 patients in PC group but only one patient in AVF group showed infection ($P = 0.006$), while in each group, three cases of thrombosis were seen ($P = 0.58$); however, catheter dysfunction was seen in 13 patients of PC group but no patients of AVF group ($P = 0.004$). There was no difference between the two groups in Kt/V and URR at the beginning of the study; however, after six months, Kt/V and URR were greater in AVF group ($P < 0.05$). **Conclusions:** In addition to some advantages of AVF over PC, such as lower rate of infection and thrombosis, we also found better dialysis adequacy in AVF group. We recommend that AVF be created in all of patients with chronic kidney disease who are candidates for hemodialysis.

Keywords: *Arteriovenous fistula, dialysis adequacy, hemodialysis, permanent catheter*

Introduction

Chronic kidney disease (CKD) is a common and serious disease worldwide. CKD can lead to end-stage renal disease.[1,2] Aging, diabetes mellitus, hypertension, and cardiovascular disease are some common and important risk factors for CKD.[3,4] Since severe renal failure is incompatible with life, renal replacement therapy with hemodialysis, peritoneal dialysis, or kidney transplantation should be carried out at this stage.[5]

Hemodialysis is indeed the most common type of renal replacement therapy in many countries,[6] and therefore vascular accesses including arteriovenous fistula (AVF), intravascular catheters, and vascular grafts (VGs) are essential to conduct hemodialysis procedure.[7,8] In addition, AVF is preferred over the other hemodialysis accesses because of lower risk of infection and thrombosis.[9,10] Longer access survival rate, shorter hospitalization, and less mortality and morbidity have been reported in patients with AVF, as well.[11] However, in some cases such as diabetes mellitus, heart failure, peripheral vascular disease, obesity or elderly patients, insertion of AVF is difficult or contraindicated, therefore in these patients, insertion of tunneled cuff catheters may be the preferred method.[12-14] The most serious and life-threatening complication of permanent catheters (PCs) is infection.[15]

Three types of catheter-related infections were reported to be exit site infection, tunnel infection, and bacteremia due to the intraluminal route of infection.[16] Moreover, superiority of AVF to catheter in terms of infection and thrombosis has been demonstrated shown in many studies;[17-19] however, there are few studies about comparison of these two types of vascular access in terms of dialysis adequacy.[11] The aim of this study was to compare these two methods regarding adequacy of dialysis, acid-base, and electrolyte abnormality.

Materials and Methods

In this prospective study from March 2013 to September 2013, 76 hemodialysis

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patients in two unequal groups of AVF and PC were enrolled in Shahrekord city; the inclusion criteria were age >18 years and dialysis duration of at least six months. The exclusion criteria were non-cooperation of the patients or change of dialysis access, such as a change to PC from AVF and vice versa, during the study. Before the dialysis session, blood samples were taken for laboratory examinations.

We did our best to keep size of the membrane, flow rate, dialysis sessions per week, duration of dialysis, and medication unchanged during the study.

At the end of hemodialysis session, blood flow rate decreased to 50 ml/min, and blood samples were taken to measure urea reduction ratio (URR) and Kt/V. The patients were followed up for six months, and laboratory examinations were repeated at the completion of the follow-up. The data were analyzed by the Statistical Package for the Social Sciences (version 19.0, SPSS Inc., Chicago, IL, USA) using *t*-test, Chi-square, Mann–Whitney, and Wilcoxon tests. All parameters were described as mean ± standard deviation and $P < 0.05$ was considered statistically significant.

All information and data were kept confidential, and informed consent was provided by the patients to take samples at enrollment. The study was funded by the Research and Technology Deputy of the Shahrekord University of Medical Sciences. The study protocol was approved by the Ethics Committee of the Shahrekord University of Medical Sciences (approval number 1005).

Results

In this study on 76 hemodialysis patients in Shahrekord, 30 patients had AVF, and 46 patients had PC. There was no significant difference between the two groups of the patients in body mass index and number of dialysis sessions per week; however, duration of dialysis (year) in AVF group was greater than PC group [Table 1]. During six months of follow-up, 24 patients in PC group and only one patient in AVF group presented infection ($P = 0.006$). In each group, three cases of thrombosis were seen ($P = 0.58$). Catheter dysfunction was seen in 13 cases of PC group but in no patients in AVF group ($P = 0.004$).

There was no significant difference in Kt/V at the beginning and the end of the study in the AVF group (0.57) or the PC group ($P = 0.21$). Furthermore, URR was similar at the beginning and the end of the study in AVF group (0.057) and PC group ($P = 0.06$).

There was also no significant difference between the two groups of the patients in URR ($P = 0.23$) and Kt/V ($P = 0.09$) in the beginning of the study; however, after six months, URR ($P = 0.02$) and Kt/V ($P = 0.03$) were significantly greater in AVF group. Serum iron, total iron binding capacity, and pH were higher in the patients of AVF group at the beginning and end of the study. There was also no significant difference between the two groups of the patients in serum triglyceride, cholesterol, calcium, phosphorus, parathormone, bicarbonate, hemoglobin, hematocrit, and albumin at the beginning of the study or six months later [Table 2].

Table 1: Demographic characteristics of the patients

Variables	Type of access	Mean±SD	*P*
Age (year)	PC	61.98±16.35	0.007
	AVF	50.83±17.95	
BMI (kg/m^2)	PC	22.02±3.93	0.06
	AVF	24.06±5.39	
Duration of dialysis (year)	PC	2.63±2.05	0.001
	AVF	5.47±4.94	
Number of dialysis per week	PC	2.59±0.50	0.099
	AVF	2.77±0.43	

PC: Permanent catheter, AVF: Arteriovenous fistula, BMI: Body mass index, SD: Standard deviation

During the study, we did not find any serious complications such as rupture of pseudoaneurysm, skin necrosis, hand ischemia, or hyperdynamic syndrome. Hand edema due to vascular stenosis at the proximal of the fistula was found in one of the patients who was referred to vascular surgeon for AVF repair.

Discussion

The study showed that AVF was superior to PC in terms of lower frequency of thrombosis, access dysfunction, infection, and dialysis adequacy (Kt/V and URR).

Infection of the vascular access is a major risk factor for morbidity and mortality in hemodialysis patients. The incidence of infection in PC is much (approximately 10 times) higher than AVF.[20] There are various types of catheter-related infections such as exit site infection, tunneled infection, and bacteremia. In different studies, risk of infection in PC was reported to be about 2.5–5.5 episodes per 1000 catheter-days.[21,22] In this study, the rate of catheter-related infection was also much higher in PC group compared to AVF group (24 episodes vs. 1 episode).

There are many studies on comparison of the AVF, PC, and VG. For example, Moyano *et al.* showed fewer complications in PC than VGs in hemodialysis patients; however, the main cause of failure could be thrombosis and infection in both methods.[23] In a study on hemodialysis patients with PC, Moist *et al.* found that blood flow rate <300 ml/min was not commonly an indication for dialysis inadequacy, therefore other predisposing factors should be kept in mind as well.[24]

In addition, there are some studies about comparison of dialysis adequacy in different types of vascular accesses with inconsistent results. For example, Canaud *et al.* conducted a study on 42 hemodialysis patients in two

Table 2: Comparison of variables in two groups of the patients in the beginning and after six months follow-up

Time	Group	BUN	Cr	Hb	Ca	*P*	PTH	HCO_3	Alb	URR	Kt/V
Before	AVF	70.67±17.18	6.33±1.36	10.73±1.23	8.93±0.20	5±0.78	498.33±319.19	21.95±3.51	4.99±0.56	0.71±0.04	1.54±0.21
	PC	68.57±23.47	6.81±2.02	10.14±1.07	8.95±0.18	4.99±0.71	551.46±368.25	21.68±3.73	5.01±0.67	0.70±0.04	1.47±0.18
	P	0.67	0.22	0.10	0.69	0.87	0.52	0.75	0.90	0.23	0.09
After	AVF	66.63±13.23	9.3±2.88	9.76±1.67	9.41±0.84	4.08±0.72	377.67±230.08	24.69±5.84	4.47±0.7	0.71±0.04	1.51±0.20
	PC	59.02±16	8±3.18	9.1±1.33	9.15±0.54	3.8±0.64	394.09±245.15	25.56±6.36	4.33±0.59	0.67±0.06	1.37±0.29
	P	0.03	0.08	0.06	0.11	0.07	0.77	0.55	0.34	0.02	0.03

BUN: Blood urea nitrogen, Cr: Creatinine, Hb: Hemoglobin, Ca: Calcium, P: Phosphorus, PTH: Parathormone, HCO_3: Na bicarbonate, Alb: Albumin, AVF: Arteriovenous fistula, PC: Permanent catheter, URR: Urea reduction ratio, Before: Beginning of the study, After: After six months

periods of 12 months each. During the first 12-month period, hemodialysis was continued with PC and then AVF inserted for additional 12 months. They concluded that dialysis adequacy (measured by Kt/V) was slightly lower in PC compared to AVF; therefore, they offered longer dialysis sessions for patients with PC.[25] Moreover, Canaud *et al.* carried out a study on hemodialysis patients with temporary catheter (TC), PC, and AVF, and found that dialysis adequacy and mean blood flow were greater in PC compared to TC and greatest in patients with AVF.[25] Ethier *et al*. in a multicenter study in some countries showed that in hemodialysis patients with AVF, dialysis adequacy was higher than patients with PC; in addition, they concluded that after AVF, preferred vascular access was VG.[26]

Tonelli *et al*. in a study on 53 hemodialysis patients, after three weeks of follow-up, concluded that adequate Kt/V was achieved in AVF and PC groups but the surprisingly time of prescribed dialysis was higher in the AVF group. However, in this study, AVF was superior regarding dialysis adequacy, therefore it seems that inconsistency in the results of above studies may be due to different sample size or difference in duration of follow-up.[27]

Canaud *et al*. in a study on hemodialysis patients showed that PC is an excellent access with low frequency of complications for elderly patients.[28] Lee *et al*., in a study about the comparison between AVF and grafts, reported a higher primary failure rate, longer catheter dependence, and more frequent catheter-related bacteremia in the fistula.[29] Furthermore, Hicks *et al.* reported that AVF was superior to VG and PC regardless of the patient's age. In contrast, VG may be superior to PC in the patients aged >48 or <18 years.[30] Banerjee *et al.* in a study on 583 hemodialysis patients showed greater inflammation and mortality in hemodialysis patients with PC compared to AVF, and therefore recommended the early removal or avoidance of PC placements.[31] Karkar *et al*. in a study on 358 hemodialysis patients reported decrease in infection and thrombosis, increase in average blood flow, improvement of average single pool Kt/V, increase in hemoglobin, improvement of serum albumin, reduction in administered erythropoietin dose, and significant decline in hospitalization. They concluded that AVF was superior to PC in terms of the quality of hemodialysis and patient outcome.[32] Our results are in agreement with those of the above-cited studies particularly in terms of infection, thrombosis, and hospital admission. However, we did not find significant differences in serum albumin or hemoglobin between the two groups of the patients. Miller *et al*. in a study on 101 hemodialysis patients showed that AVF adequacy (defined as blood flow rate >350 ml/min) was not affected by serum albumin.[33]

It should be mentioned that some complications may occur only in AVF patients including anastomotic pseudoaneurysm, a rare AVF complication that may lead to dysfunction, rupture or complicated by infection), skin necrosis due to frequent fistula puncturing that may be complicated by severe or life-threatening bleeding, hand ischemia that may lead to gangrene of fingers, hyperdynamic syndrome due to significant increase blood flow through the fistula that can lead to heart failure, fistula stenosis that may require fistula angiography and repair by angioplasty.[34,35] We did not see any of these serious events in the AVF group patients during this study.

This study had certain limitations such as small sample size and short duration of follow-up, and therefore it is recommended to conduct similar studies with larger sample size and longer duration of follow-up.

Conclusions

In addition to some advantages of AVF over PC such as lower rate of infection and thrombosis, which have been reported in some studies,[12,25,32,34] we found better dialysis adequacy, therefore the creation of AVF is suggested for all of CKD patients who are candidates for hemodialysis.

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Conflicts of interest

There are no conflicts of interest.

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