Special Report

Access Recirculation in Permanent Catheters of Hemodialysis Patients

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Treatment for end stage renal disease patients is based on dialysis; however, the presence of access recirculation (AR) decreases dialysis efficiency and adequacy. This study was conducted to determine the recirculation rate in dialysis patients undergoing hemodialysis through using a permanent catheter. 60 patients including 23 males and 37 females were enrolled. Mean age of the participants was 57.66 (± 14.08) years. Mean AR in the subjects was 9.36%, and 16 (27%) of patients had mean AR above 10%. Moreover, there was a significant correlation between AR and catheter longevity ($P < .001$). It is suggested to limit the use of permanent catheters to specific cases and not to use them in place of arteriovenous fistulas.

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INTRODUCTION

Chronic Kidney Disease (CKD) is a spectrum of various pathophysiologic processes associated with abnormal kidney function and progressive reduction in the glomerular filtration rate (GFR). It is estimated that at least 6% of the adult population in the United States suffer from CKD Stages 1 and 2, and 4.5% from CKD Stages 3 and 4. Five of the most common causes of CKD, responsible for more than 90% of the burden of CKD worldwide; are: diabetic nephropathy, glomerulonephritis, hypertension with CKD, autosomal dominant polycystic kidney disease and other cystic nephropathies, and tubulointerstitial diseases.[1] CKD Stages 1 and 2 usually do not have symptoms caused by GFR reduction. If GFR reduction causes CKD Stages 3 and 4, the clinical and laboratory effects of CKD will be more prominent.[2] The term end stage renal disease (ESRD) represents a CKD stage, in which accumulation of toxic substances; fluids and electrolyte imbalances cause uremic syndrome that can lead to death unless it is treated by renal replacement therapy using dialysis or kidney transplant, and all accumulated poisons are removed.[1] Hemodialysis and kidney transplants have elongated the lives of hundreds of thousands of CKD patients worldwide.[3] There are three main components for dialysis: dialysis machine, dialysis fluid, and circulatory system. The blood transfusion system consists of an exogenous flow in a dialysis machine and a vascular access pathway. A fistula, graft, or catheter; through which blood passes to a dialysis machine, is called vascular access. A fistula has a high long-term success rate among all vascular dialysis options; however, fistulas are only created in a minority of patients in the United States. Most patients are subjected to placement of arteriovenous grafts or permanent dialysis catheters. Grafts and catheters are more suitable for patients with thinner or damaged veins. Typically, when intravenous artery fistulas and grafts are either inefficient or not usable due to anatomical considerations, tunnel catheters are useful for cases with stable hemodialysis. Tunnel catheters are mostly located in the internal jugular vein, external jugular vein, femoral, and subclavian veins. Sufficient dialysis is highly important and increases the patient survival rate. One way to evaluate dialysis adequacy is to measure the Kt/V ratio.[2,4] Access recirculation

(AR) is considered as one of the factors affecting hemodialysis adequacy[5] (10-3) and it occurs when the dialyzed blood returns to the dialysis device through the intravenous line instead of spinning in the circulatory system. Significant recirculation leads to a difference between the amount of prescribed (the prescribed Kt/V urea) and delivered hemodialysis (the delivered Kt/V urea). The AR rate can be calculated from the following formula:

Percent recirculation: (CP - CA) / (CP - CV) × 100

CP = Concentration of peripheral blood urea

CV = Concentration of venous blood urea

CA = Concentration of arterial blood urea

If there is no recirculation, the blood urea nitrogen of the peripheral blood should be equal to that of the arterial blood. In fact, the numerator of the above fraction should be zero.[6]

MATERIALS AND METHODS

In this cross-sectional study, all patients referred to the dialysis department of the Shahid Beheshti Hospital and the Besat Hospital, Hamedan, Iran; who were under hemodialysis treatment through permanent catheters, enrolled in the study after signing a written informed consent. All the patients were hemodialyzed for 4 hours, three times a week. During hemodialysis, we discontinued ultrafiltration after 30 minutes from the start of hemodialysis and simultaneously a sample of arterial blood flow (CA) and a sample of venous line (CV) were taken respectively as arterial and venous blood samples. Moreover, pump blood flow (QB) was reduced to 50 mL/min and after 30 seconds (the time required to remove the dead space of the arterial line, it means that after passing 150% of the blood volume within the arterial and venous needle distance), ultrafiltration was discontinued again. Afterwards, a blood sample was taken from the arterial line to determine the peripheral blood urea concentration (CP). Subsequently, the samples were sent to the hospital laboratory and all the specimens were measured using a quantitative diagnostic kit (made by Pars Azmon Company) based on a photometric method with a BT 3000 auto analyzer (Italy). Before the auto analyzer began to work, the device was checked with a control sample and the analysis accuracy was assured. In the final stage, based on the amount of the measured urea, the AR rate was calculated from the above formula.

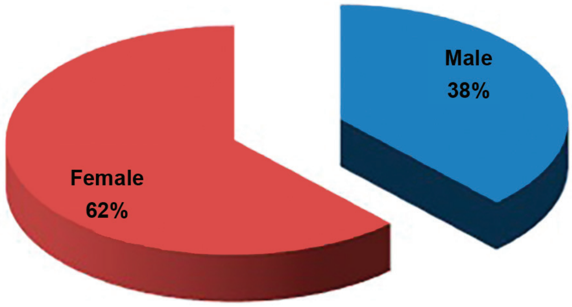

Figure 1. It showed the gender frequency distribution in the studied subjects.

RESULTS

Distribution of the Patients

In this study, 60 patients underwent a routine hemodialysis with permanent catheters enrolled. The mean age of the participants was 57.66 (± 14.08) years, with their minimum and maximum age being 27 and 91 years; respectively. Figure 1 showed the gender frequency distribution in the studied subjects.

Frequency of Permanent Catheter Placement in Patients

The most common catheter location was the right jugular vein. The Table 1 describes the permanent catheter location frequency. The most commonly reported disease in the studied patients, as the cause of renal failure, was diabetes. The Table 2

Table 1. The Permanent Catheter Location Frequency

Catheter Placement	Number of Patients (Person)	Percent (%)
Right Jugular	47	78.3
Left Jugular	4	6.7
Right Femoral	5	8.3
Left Femoral	2	3.3
Right Subclavian	2	3.3
Left Subclavian	0	0
Total	60	100

Table 2. The Frequency of the Underlying Cause of Renal Failure

Cause	Frequency	Percent (%)
Diabetes	23	38.3
Hypertension	22	36.7
Polycystic Kidney	2	3.3
Reflux Uropathy	3	5
Glomerulonephritis	5	8.3
Unknown	5	8.3
Total	60	100

demonstrated the frequency of the underlying cause of renal failure.

Correlation Between AR With Other Parameters

The ANOVA statistical test did not show any significant correlation between the AR rate and renal failure causes ($P > .05$). The mean duration of catheter placement ranged from 15 days to 50 months with an average of 13.26 ± (11.23) months. The catheter respectively had a maximum and minimum length of 40 cm and 18 cm with an average of 24.86 ± (4.7). Mean AR in the subjects was 9.36% with a maximum of 28% and minimum of 0%. Mean AR based on gender is presented in the Table 3. Statistically, there was no significant difference between male and female in terms of the AR rate ($P > .05$). Moreover, 16 subjects had mean AR above 10% while 44 subjects had ≤ 10%. The findings on the assessment of the two groups in terms of AR with regard to length, catheter longevity and patient age are presented in the Table 4.

The correlation between catheter longevity and the AR rate based on the Pearson correlation coefficient is plotted in the following diagram (Figure 2). Regarding the correlation coefficient ($P > .05$), we concluded that there was a moderate correlation between these two variables (Figure 2).

AR in Permanent Catheters in the Hemodialysis Patients

In this study, 60 patients were included, of whom 23 were male (38.5%) and 37 were female

Table 3. Mean AR Based on Gender

Gender	Frequency	Mean
Man	23	8.52
Woman	37	9.89

Table 4. Comparison of Length, Catheter Longevity, and Patient Age Between the 2 Groups With the AR Mean of Above and Below 10%

Recirculation	Mean (cm)	*P*
Catheter Length, cm		
≤ %10	25.22	> .05
> %10	23.87	
Catheter Longevity, month		
≤ %10	9.10	< .001
> %10	24.50	
Mean of Patient's Age, year		
≤ %10	57.90	> .05
> %10	57	

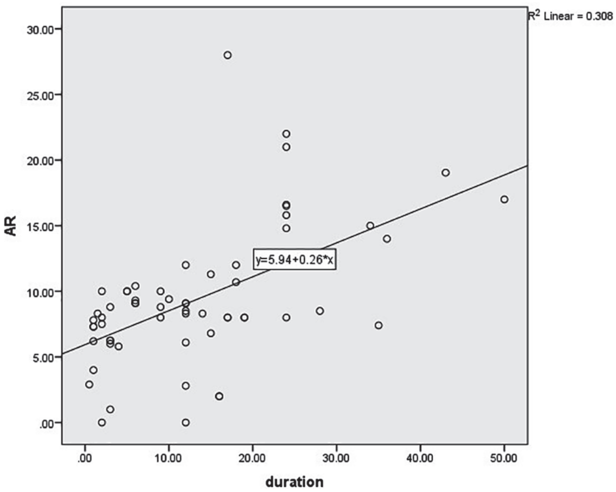

Figure 2. It demonstrated the correlation diagram of catheter longevity and the AR rate.

(61.5%), with the female to male ratio of 1.6 to 1. Based on our research, most of studies were carried out on the recirculation of arterial venous fistulas and limited studies were performed on AR in permanent catheters. In the following studies, only Abbasi *et al.*[7] and Atapour[8] studies were conducted on the recirculation of catheters. In Abbasi *et al.* study (13), 83 patients with dialysis catheters were included, of whom 54 (65%) were male and 29 (35%) were female; while in Atapour study, 53% of patients (16 patients) were male and 15 were female. Moreover, in Salimi *et al.* study,[9] 30 patients were male and 21 patients were female. Further, in Gholiaf *et al.* study (12), 32 patients were studied; of whom 19 (59%) were male and 13 (41%) were female. The mean age of the participants in our study was 57.66 (± 14.08) years, with their minimum and maximum age being 27 and 91 years; respectively. In Atapour study, the patients had an average age of 52 ± 15.7 and an age range of 19 to 81 years whereas in Abbasi study; the mean age was 58.7 years. Moreover, in Mahboob *et al.* study;[10] patients were between 18 and 75 years, with an average age of 95.11 ± 81.43 years. In Salimi *et al.* study, the mean age of the subjects was 55.33 ± 15.77; with an age range of 17 to 85 years. The subjects studied in this study were more similar to those studied by Abbasi and his colleagues. In our study, the most common underlying disease in the patients with renal failure was diabetes (38% of the patients). In Abbasi research, 35% of patients had diabetes and 24% had hypertension; while in Salimi study, only

25% had diabetes and hypertension had a higher percentage. In resources, diabetes is the most common underlying cause of renal failure, which is in agreement with the results of Abbasi study and our research. The mean AR in the subjects in the present study was 9.36% with a maximum and minimum of 28% and 0%, respectively; although, 16 patients had a mean AR above 10%. The t-test results showed no significant correlation between this group of patients and catheter length ($P > .05$), while there was a significant correlation between catheter longevity and the AR rate ($P < .001$); similarly, the Pearson coefficient showed a moderate correlation between these two variables. The findings are justifiable considering the greater possibility of catheter dysfunction and thrombosis in catheters that last longer. In Atapour study on 30 hemodialysis patients, 25 patients with permanent catheters and five patients with temporary catheters underwent hemodialysis. The AR rate in the patients with permanent and temporary catheters was 6.9 ± 6.7 and 7.8 ± 8.4, respectively. In Abbasi *et al.* research, which measured the AR rate in two groups of hemodialysis patients through using fistulas and permanent catheters; the AR rate, was 11.6% in all patients. Totally, 43 patients (51.81%) had the AR rate below 10% while 40 patients (48.19%) had the AR rate above 10%, with the highest and lowest rate being 50% and 0%; respectively. In the groups with fistulas and permanent catheters, 12.52% (29 patients) 9.5% were reported; respectively, which is similar to the findings of this study. However, none of the reviewed studies analyzed factors affecting AR in permanent catheters; in some cases, which analyzed the AR rate in fistulas, a similar finding was obtained.[6c] It may be concluded that in all types of access hemodialysis, increasing longevity results in decreasing both their function and the AR rate. This emphasizes the need for regular evaluation of long lasting accesses. In the study of the correlation between caterer length and the AR rate, the Pearson correlation coefficient was below zero. This means that in cases that catheter length increases, the AR rate decreases. However, further studies are recommended to thoroughly examine this weak correlation. In the present study, there was no significant correlation between the AR rate with catheter length, catheter placement, patient age and underlying disease.

CONCLUSION

Based on the findings of the present study, the AR rate was considerably high among hemodialysis patients undergoing hemodialysis through permanent catheters. Therefore, it is recommended to limit the use of permanent catheters to specific cases and not to use them in place of arteriovenous fistulas.

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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