Access Recirculation in Jugular Venous Catheter in Regular and Reversed Lines

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Introduction. The aim of this study was to determine access recirculation in functioning catheters in the regular and reversed positions.

Materials and Methods. Access recirculation was measured in 2 sequential hemodialysis sessions in patients with functioning internal jugular catheters inserted not earlier than 2 weeks before the study. The arterial and venous lines were in their regular position during the first session and they were reversed during the second measurement. Changes in access recirculation were assessed. Also, type of the catheter and number of catheter insertions were evaluated in relation to access recirculation.

Results. Twenty-five of the patients had a permanent catheter and 5 had a temporary catheter. During the first session, the mean of access recirculation was 6.9 ± 6.7% in the patients with a permanent catheter and 7.8 ± 8.4% in those with a temporary catheter (P = .45). The mean access recirculation was 7.1 ± 6.9% (range, 0 to 20%) in the 30 patients on hemodialysis with the arterial and venous lines in their regular positions. When the lines were reversed, access recirculation increased significantly (P = .01) to a mean of 20.5 ± 20.5% (range, 2.3% to 75%). There was no significant correlation between the type of catheter or the number of catheter insertions and access recirculation.

Conclusions. After reversing the arterial and venous lines, access recirculation in both temporary and permanent functioning catheters may increase; therefore, dialysis adequacy might be impaired by reversed lines. Replacing malfunctioning catheters with new ones seems to be better than reversing the lines.

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INTRODUCTION

Permanent vascular access with central venous catheters has become increasingly important because of the characteristics and the clinical problems of patients who undergo temporary or long-term hemodialysis.[1] Aiming at an early diagnosis of access dysfunction and elective repair of a failing access, the *National Kidney Foundation* Clinical Practice Guidelines for Hemodialysis Adequacy recommends that all patients on hemodialysis undergo regular monitoring.[2] Assessment of access recirculation is crucial to avoid inefficiency of hemodialysis and a regular monitoring of vascular access is recommend through several methods such as vascular access recirculation.[3] In several circumstances during hemodialysis, the regular direction of blood flow has to be reversed; access dysfunction or insufficient blood flow being obtained through the arterial port

are some instances.[4] Increasing access recirculation due to reversed lines may impair dialysis adequacy. The aim of this study is to determine the access recirculation in functioning catheters in the regular and reversed positions, to predict reversing line effect on malfunctioning catheters.

MATERIALS AND METHODS

During 2007, there were 180 patients with end-stage renal disease on maintenance dialysis in our university-affiliated hemodialysis center. Forty-six of them were on hemodialysis with internal jugular catheters. All temporary catheters were dual lumen, 12 F, and 16 cm (Arrow Inc, reading, USA) and permanent catheters were dual lumen Hemocath, 12.5 F, 28 cm, and w/blunt trocar (Cardiomed supplies Inc, Gormley, Ontario, Canada). All of them had been inserted in the right jugular vein and despite the length difference due to subcutaneous tunneling in 28-cm catheters, their tips were in the beginning of the right atrium.

We excluded patients who had malfunctioning catheters, venous pressure more than 200 mm Hg, arterial pressure less than -150 mm Hg, or catheters inserted more than 2 weeks earlier. Ultimately, we enrolled 30 eligible patients who consented to participate in this clinical trial.

Access recirculation was measured during 2 sequential hemodialysis sessions. Demographic information, type of catheter, and the number of insertions were noted. We used the low-flow method, which has been shown as a reliable evaluation of access recirculation.[5] In all hemodialysis sessions, blood flow was constant (350 mL/min), dialysate flow was 500 mL/min, and the temperature was 36.5°C. The dialyzer was primed with 2000 U of heparin, continued with 1000 U/h of heparin for 3 hours, and discontinued during the last hour. In the first session, 30 minutes after the beginning of hemodialysis without ultrafiltration, 3 blood samples were taken for blood urea nitrogen (BUN): one arterial sample (A) from the arterial line, one venous sample (V) from the venues line, and one peripheral sample (P) from the arterial line 15 seconds after decreasing blood flow to 50 mL/min. In the second session, the arterial and venues lines of hemodialysis were reversed and 30 minutes after the beginning of hemodialysis without ultrafiltration, 3 similar samples (A, V, and P) were taken as in previous session. After sampling, the arterial and venous lines were turned into the correct position for the rest of the hemodialysis. Access recirculation was calculated as:

$$\text{Access Recirculation} = (P_{BUN} - A_{BUN})/(P_{BUN} - V_{BUN}) \times 100$$

In which the P_{BUN}, A_{BUN}, and V_{BUN} were the BUN concentrations in the P, A, and V samples, respectively.

Statistical analyses were done by SPSS software (Statistical Package for the Social Sciences, version 12.0, SPSS Inc, Chicago, Ill, USA), and the Mann Whitney U test, the paired *t* test, the Wilcoxon signed rank test, and the Kruskal-Wallis test were used to compare the results. Continuous variables were demonstrated as mean ± standard deviation. A *P* value less than .05 was considered significant.

RESULTS

The study population consisted of 30 patients on hemodialysis aged between 19 and 81 years old (mean, 52.0 ± 15.7). Sixteen of them (53.3%) were men and 15 (46.7%) were women. Twenty-five of the patients (83.3%) had a permanent catheter and 5 (16.7%) had a temporary catheter. Sixteen patients (53.3%) had more than once catheter insertion.

During the first session, the mean of access recirculation was 6.9 ± 6.7% in the patients with a permanent catheter and 7.8 ± 8.4% in those with a temporary catheter (*P* = .45). These values increased to 19.1 ± 19.0% and 26.9 ± 28.2%, respectively, in the second session. There was no significant correlation between the type of catheter or the number of catheter insertions and access recirculation (Tables 1 and 2)

Overall, access recirculation varied from zero to 20% with mean values of 7.1 ± 6.9% in the 30 patients on hemodialysis with the arterial and venous lines in their regular positions. When the lines were reversed, access recirculation increased significantly (*P* = .01) to a mean of 20.5± 20.5% (range, 2.3% to 75%).

Table 1. Mean Ranks of Access Recirculation in Patients With Permanent and Temporary Catheters

Parameters	Catheter		*P**
	Permanent	Temporary	
Number of patients (%)	25	5	…
Access recirculation, %			
Regular lines	15.34	16.30	.82
Reversed lines	14.92	18.40	.42

*Mann Whitney U test. Ellipsis indicates not applicable.

Table 2. Access Recirculation in Patients With Different Numbers of Catheter Insertions

Parameters	Number of Catheter Insertions				*P**
	1	2	3	4	
Number of patients	16	10	3	1	…
Access recirculation, %					
Regular lines	6.6 ± 7.1	7.8 ± 6.2	9.5 ± 10.0	0	.12
Reversed lines	22.0 ± 21.6	21.7 ± 22.4	12.4 ± 9.0	8.1	.06

*Kruskal-Wallis test. Ellipsis indicates not applicable.

DISCUSSION

Access dysfunction impairs hemodialysis adequacy and results in costly healthcare for the providers.[6] The use of central catheters in an inversed position can result in a higher recirculation rate. Reversing the lines of the central catheters may lead to less effective hemodialysis and it seems particularly important for the nursing staff to be aware of this phenomenon.[7] Dionisio and associates evaluated the internal jugular catheters under normal conditions and when the arterial lumen of the catheter is used as venous lumen. They found that urea recirculation rate was less than 5% for almost all patients under normal condition, and it increased to a mean 5.1 ± 1.8% ($P < .001$) when venous lines were used as arterial line. It was concluded that during hemodialysis with dual lumen internal jugular catheters, efficient treatment can be provided in normal condition and also when the venous lumen is used as arterial lumen.[8] In another study, the expected blood recirculation in well-functioning recently inserted temporary dialysis catheters was under 5% for subclavian, over 12% in 19.5-cm femoral, and over 22% in shorter 13.5-cm femoral catheters at a blood flow rate of 300 mL/min.[9] In our study, samples were collected from patients with internal jugular catheter and access recirculation in the jugular vein was 7.1 ± 6.9% at a blood flow rate of 350 mL/min, which was mildly above the expected value. We did not measure urea reduction rate, but dialysis efficiency might be decreased due to a higher access recirculation even in the correct arterial and venous line positions.

Oguzkurt and colleagues showed that short-term catheters result in significantly high rates of pericatheter sleeve and thrombus formation.[10] These are 2 important causes of catheter malfunction. In their study, 32 patients (56%) had had only 1 temporary catheter and 24 (44%) had had more than 1 inserted. The mean dwell time for the catheters was 21 days (range, 7 to 59 days). Thrombus formation was noted in 16 patients (28%). Three out of 15 patients (20%) who had diagnostic venography for the internal jugular vein had severe stenosis of the vein, an important cause of access malfunction.[10] In our study we included the ones who had their catheters for less than 2 weeks and excluded those with malfunctioning catheters. Sixteen patients (53.3%) had 1 catheter insertion and the rest had had more than 1 insertions. There was no significant correlation between number of catheter insertion and access recirculation, but access recirculation increased in all cases by reversing the arterial and venous lines. Hassan and colleagues showed that reversed hook-up of a well-functioning Tesio Twin catheter is associated with a significant decline in blood flow and BUN clearance, but no change in the percentage of recirculation; however, inadvertent reversed hook-up of a well-functioning Permcath could lead to a considerable increase in the percentage of recirculation, but no change in blood flow or BUN clearance.[11] In the current study, blood flow and dialysate flow were constant during all dialysis sessions with correct and reversed lines. We did not measure the real blood flow, but there was a significant increase in access recirculation in both temporary and permanent functional catheter after reversing the arterial and venous lines. We did not measure urea reduction rate either, but it seems that as in functional catheters, reversing the arterial and venous lines in malfunctioned ones might increase access recirculation and decrease dialysis adequacy. However, studying larger samples with functional and malfunctioning catheters is warranted for further confirmation of our results.

CONCLUSIONS

In our patients with functional dialysis catheters, access recirculation increased with both temporary and permanent functional catheters after reversing

the arterial and venous lines; therefore, it might decrease dialysis adequacy. It seems that, replacing malfunctioned catheter with a new one is better than reversing arterial and venous lines.

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CONFLICT OF INTEREST

None declared.

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