The impact of blood flow rate on dialysis dose and phosphate removal

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Introduction:

Inadequacy of dialysis is associated with morbidity and mortality in chronic hemodialysis patients (1). Hyperphosphatemia is highly prevalent in hemodialysis and is a major risk factor of vascular calcifications (2). Blood flow rate (BFR) during hemodialysis is one of the important determinants of increasing dialysis dose. The aim of this study was to determine the effect of increasing BFR on dialysis dose evaluated by urea reduction ratio (URR) and Kt/V, and on phosphate removal assessed by the percentage of phosphate reduction (PPR).

Methodes:

The trial was designed as a prospective interventional study assessing the impact of increasing BFR from 250 to 350 ml/min on dialysis dose and phosphate removal. The study was devised into 2 phases, each phase comprised one hemodialysis session per patient. In the first phase the BFR was regulated at 250 ml/min and in the second phase it was increased to 350 ml/min without changing the other dialysis parameters for each patient. The patients' body weight was recorded and blood samples (serum urea and phosphate) collected before and after dialysis session. For assessing the efficacy of dialysis, URR, $Kt/V_{Diascan}$, $Kt/V_{Daugirdas}$, equilibrated Kt/V (Kt/V_{equi}) and PPR were used.

Results :

A total of 22 patients were enrolled.

TABLE1: CHARACTERISTICS OF THE PATIENTS INCLUDED IN THE STUDY

Variable	Value
Number of patients	22
Age (years)	55.36 ± 15.82
Gender n (%)	
Male	12 (54.54)
Female	10 (45.45)
Causes of ESRD† n (%)	
Diabetes	10 (45.45)
Hypertension	3 (13.63)
Glomerulonephritis	1 (4.54)
Lithiasis	1 (4.54)
Gout	1 (4.54)
Reflux	1 (4.54)
Unknown	5 (22.72)
Duration of dialysis (months)	61.81 [23.25 - 108] ‡
Height (cm)	149.96 ± 48.64
Body Mass Index (kg/m^2)	23.07 ± 4.50
Morbidity n (%)	
Diabetes	10 (45.45)
Ischemic cardiopathy	3 (13.63)
Peripheral arterial occlusive disease	2 (9.09)

Data are expressed as number and percentage or mean ± standard deviation; † = end-stage renal disease; ‡ expressed as median [quartiles]

TABLE2: DIALYSIS PARAMETERS

Variable	Value
Vascular access n (%)	
Arteriovenous fistula	18 (81.81)
Tunneled catheter	2 (9.09)
Arteriovenous graft	2 (9.09)
Dialyzer membrane n (%)	
High Flux 1,4 m^2	4 (18.18)
High Flux 1,7 m^2	7 (31.81)
High Flux 2,1 m^2	11 (50)
Anticoagulation n (%)	
Enoxaparine 2000 ui	4 (18.18)
Enoxaparine 4000 ui	18 (81.81)
Dry weight (kg)	61.87 ±11.53

Increasing BFR by 100 ml/min (40%) was associated with an increase in URR by 11.03 %, in $Kt/V_{Diascan}$ by 25%, in $Kt/V_{Daugirdas}$ by 35.58 %, in Kt/V_{equi} by 34.81 % and in PPR by 22.9%. Adequate dialysis, defined by a spKt/V≥1.4, was achieved, according to two methods: $Kt/V_{Diascan}$, $Kt/V_{Daugirdas}$, respectively in 18.18 % and 72.72% of the cases using a BFR of 250 ml/min and in 68.18 % and 100% of the cases using a BFR of 350 ml/min.

TABLE 3: EFFECT OF INCREASING BLOOD FLOW RATE ON DIALYSIS EFFICIENCY

Variable	Blood flow rate 250ml/min	Blood flow rate 350ml/min	*P* value
Urea Reduction Ratio (%)	73.41 ± 5.94	81.51 ± 6.13	< 0.001
$Kt/V_{Diascan}$	1.16 ± 0.27	1.45 ± 0.15	< 0.001
$Kt/V_{Daugirdas}$	1.54 ± 0.26	2.08 ± 0.73	0.001
Equilibrated Kt/V	1.35 ± 0.22	1.82 ± 0.61	0.001
Percentage of Phosphate Reduction (%)	48.20 ± 13.06	59.25 ± 13.84	0.01

Data are expressed as mean ± standard deviation; P value lower than 0, 05 was considered statistically significant.

Discussion:

The BFR is different in many countries and the optimal BFR has been unclear. The Dialysis Outcomes and Practice Patterns Study (DOPPS) has shown that in the United States, the patients that BFR is more than 400 ml/min account for 83.6% of the HD patients. In Canada and other Europe, the patients with BFR ≥ 250 ml/min take about 98% of the HD patients (3). However, in Japan, the patients with BFR ≥ 250 ml/min account for 18% and BFR prescribed usually 200 ml/min for a typical HD treatment (4).

Some investigators suggest that the use of low BFR may contribute the longer survival by facilitating the maintenance of high rate of arteriovenous fistula (4,5). On the contrary, other studies demonstrated that increased BFR is important for optimizing dialysis dose and inadequate dialysis dose is associated with increased mortality (1).

Phosphate removal during HD is limited largely due to the intracellular location of most inorganic phosphorus. Serum phosphate levels decrease sharply during the first 60 to 120 minutes of dialysis and remains relatively constant thereafter, apparently independent of dialyzer blood flow and type of dialyzer membrane (6).

Conclusion: Our data further confirm that increasing the blood flow rate by 40 % is effective in increasing dialysis dose and phosphate removal in chronic hemodialysis patients.

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