CONTRIBUTION OF VOLUME STATUS TO RESIDUAL RENAL FUNCTION IN PATIENTS ON PERITONEAL DIALYSIS

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INTRODUCTION AND AIMS

Residual renal function (RRF) is an important factor that influences mortality, morbidity and the quality of life among patients on peritoneal dialysis (PD).

Some authors have proposed keeping patients slightly overhydrated in an effort to maintain RRF. However, overhydration might cause volume overload, hypertension and left ventricular hypertrophy.

Therefore, we examined relationships between volume status and RRF in patients during the first three years on PD to clarify whether overhydration is actually beneficial for the long-term preservation of RRF.

METHODS

■**Study design:** Single-center observational study
■**Subjects:** 48 PD patients treated at our hospital
■**Main outcome measure:** Slope of the decline in glomerular filtration rate (GFR) and development of oliguria
■**Measurements:**
•GFR: measured as the average of renal creatinine (Cr) and urea clearances.
•Slope of the decline in GFR: calculated as regression coefficients of serial GFR.
•Volume status: Evaluated as the ratio of extracellular water (ECW) to total body water (TBW), measured using multi-frequency bioelectrical impedance analysis.
■ **Data collection:**
•Data comprising clinical findings, urinary protein excretion, PD modality and the dialysate-to-plasma creatinine (Cr) ratio (D/P Cr) determined using a standard peritoneal equilibration test at baseline, ECW/TBW, glomerular filtration rate (GFR), urine volume, blood pressure, peritoneal urea and Cr clearance, dialysate volume, ultrafiltration, dialysate glucose load and normalized protein equivalent nitrogen appearance (nPNA) were collected semiannually for three years.
•Episodes of peritonitis were also recorded during the observation period.
■**Solute clearance target:** Patients were treated with increasing dialysis doses in response to loss of RRF, to achieve a total Kt/V urea of 1.7.
■**Statistical analysis:**
- Data are expressed as mean ± SD.

•Patients were divided into two subgroups with more rapid and slower declines in GFR, according to the median slope of decline in GFR. Differences between subgroups were evaluated using unpaired Student's *t* test and the Mann-Whitney *U* test for continuous data, and Fisher's exact p value for discrete data.
•Significant variables in univariate analysis were incorporated into multivariate analysis, to identify variables showing independent assosiations with the slope of decline in GFR and development of oliguria.

RESULTS

Number of patients	48
Age (years)	56.9± 12.3
Sex (female/male)	14/34
Primary kidney disease (non-DM/DM)	6/42
Body mass index (kg/m^2)	23.2 ± 3.3
Systolic blood pressure (mmHg)	136 ± 24
Diastolic blood pressure (mmHg)	81 ± 13
ECW/TBW	0.349 ± 0.020
Modality (CAPD/APD)	23/25
Residual GFR (ml/min/1.73 m^2)	4.76 ± 2.66
Urine protein (g/day)	1.35 ± 1.29
Hemoglobin (g/dL)	10.8 ± 1.1
Serum creatinine (mg/dL)	8.39 ± 2.07
Serum urea nitrogen (mg/dL)	63.3 ± 14.3
Total Kt/V urea	1.89 ± 0.40
Total Cr clearance (L/week/1.73 m^2)	86.01 ± 35.89
nPNA (g/kg/day)	1.04 ± 0.17

Table 1. Baseline characteristics of patients.
DM, diabetes mellitus

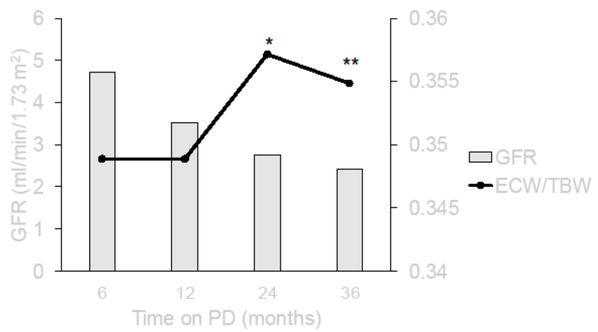

Figure 1. Change in GFR and ECW/TBW over 3 years.
*P < 0.05, **P < 0.01 vs. baseline.

- Mean slope of decline for GFR was -1.64 ± 1.93 mL/min/year/1.73 m^2
- In response to loss of RRF, ECW/TBW showed a significant increase over the first 2 years.

	Rapid (n=24)	Slow (n=24)	*P*
Age (years)	55.5 ± 13.0	58.3 ± 11.5	0.4
Sex (female/male)	4/20	10/14	0.06
Primary kidney disease (non-DM/DM)	22/2	20/4	0.7
Modality (CAPD/APD)	9/15	14/10	0.1
Baseline			
Body mass index (kg/m^2)	24.2 ± 3.6	22.1 ± 2.6	0.03
Residual GFR (ml/min/1.73 m^2)	5.67 ± 2.96	3.85 ± 1.93	0.02
Urine protein (g/day)	1.81 ± 1.43	0.89 ± 0.91	0.01
D/P Cr	0.59 ± 0.11	0.62 ± 0.13	0.5
Averaged value for observation period			
Systolic blood pressure (mmHg)	144 ± 18	134 ± 11	0.03
Diastolic blood pressure (mmHg)	84 ± 10	78 ± 10	0.04
ECW/TBW	0.354 ± 0.019	0.353 ± 0.017	0.9
Peritoneal Kt/V urea	1.09 ± 0.29	1.14 ± 0.33	0.6
Total Kt/V urea	1.82 ± 0.29	1.83 ± 0.28	0.9
Peritoneal Cr clearance (L/week/1.73 m^2)	25.36 ± 8.46	27.66 ± 10.39	0.4
Total Cr clearance (L/week/1.73 m^2)	73.04 ± 25.64	72.46 ± 25.27	0.9
Total dialysate volume (ml/day)	6644 ± 1837	5776 ± 2049	0.1
Dialysate glucose load (g/day)	87 ± 24	72 ± 28	0.07
nPNA (g/kg/day)	0.99 ± 0.17	1.00 ± 0.14	0.8
Ultrafiltration (ml/day)	484 ± 278	337 ± 344	0.1
Peritonitis rate (episodes/patient-year)	0.45	0.29	0.3

Table 2. Comparative analysis between subgroups with more rapid and slower declines in GFR, according to median slope of decline in GFR.
DM, diabetes mellitus

- Patients with more rapid decline in GFR showed significantly higher baseline GFR, higher baseline urine protein, higher baseline body mass index and higher mean blood pressure during the observation period.
- No difference in ECW/TBW was seen between the two subgroups.

Variable	Linear regression			
	Simple		Multiple	
	r	*P*	β coefficient	*P*
Age (years)	0.347	0.02		
Body mass index (kg/m^2)	-0.367	0.01		
Residual GFR (ml/min/1.73 m^2)	-0.430	0.002	-0.413	*P* < 0.001
Urine protein (g/day)	-0.510	0.04	-0.261	0.02
Mean blood pressure (mmHg)	-0.554	*P* < 0.001	-0.462	*P* < 0.001
ECW/TBW	0.143	0.3		

Table 3. Simple and multiple linear regression analysis of factors associated with the slope of decline in GFR.
ANOVA for study model: p<0.001, r = 0.753, r^2 = 0.566, adjusted r^2 = 0.537.

- Significant variables in univariate analysis including age, body mass index, baseline GFR, urine protein and averaged value of mean blood pressure during the observation period were tested by multiple linear regression using backward stepwise selection.
- Multivariate analysis identified higher baseline GFR, higher baseline urine protein and higher mean blood pressure as independently associated with rapid declines in GFR.
- No correlation seen between the slope of decline in GFR and ECW/TBW.

	Univariate		Multivariate	
Variable	HR (95%CI)	*P*	HR (95%CI)	*P*
Residual GFR (ml/min/1.73 m^2)	0.66 (0.48-0.91)	0.01	0.73 (0.53-0.99)	0.05
Urine protein (g/day)	1.32 (1.00-1.74)	0.05		
D/P Cr (per 0.1)	1.48 (1.02-2.16)	0.04		
Mean blood pressure (mmHg)	1.06 (1.01-1.10)	0.008		
Ultrafiltration (ml/day)	1.00 (1.00-1.00)	0.006		
ECW/TBW (%)	1.44 (1.10-1.88)	0.007	1.44 (1.05-1.97)	0.02

Table 3. Univariate and multivariate analysis in the Cox proportional-hazards model of factors associated with development of oliguria.

- Univariate analysis showed that lower baseline GFR and higher baseline urinary protein excretion, baseline D/P Cr, average blood pressure, average ultrafiltration and average ECW/TBW values during the observation period were associated with increased risk of development of oliguria.
- Multivariate analysis showed that lower baseline GFR and higher average ECW/TBW were independently associated with increased risk of development of oligulia.

DISCUSSION

- Higher baseline GFR, higher baseline urine protein and higher blood pressure are directly associated with rapid declines in GFR.
- Although no association was seen between the slope of decline in GFR and ECW/TBW, inadequate control of hypertension linked to overhydration is associated with declines in GFR.
- Lower baseline GFR and higher average ECW/TBW are directly associated with increased risk of development of oliguria.
- These results suggest that overhydration is not beneficial to maintain RRF.

CONCLUSION

Overhydration is not helpful for the long-term preservation of RRF.

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