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Research Article

Does Residual Renal Function Have a Beneficial Effect on Patient and Technique Survival in Peritoneal Dialysis Patients?

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Abstract

Objectives: Residual renal function (RRF) at the initiation of peritoneal dialysis (PD) therapy can be a predictor of survival in stable PD patients. The aim of the present study was to investigate PD patients regarding the effect of baseline RRF on patient and technique survival.

Methods: Urine output at the beginning of PD therapy was evaluated retrospectively in 202 PD patients. Patients were divided into two groups: patients with anuria (urine output ≤100 ml/day) and patients without anuria (urine output >100 ml/day).

Results: The number of patients with anuria was 58 in which 38 patients were females. The mean age of the patients was 42.8±14.9 years. The mean follow-up period was 44.2±35 months. Twelve percent of patients with anuria had history of hemodialysis (HD).

One hundred forty-four had no anuria (68 females, mean age 43.7±14.5 years, mean follow-up period 39.6±26.1 months, mean urine volume 592±442 ml). Twenty-three patients had received HD therapy before. Sixty-five had anuria in the following 22.5±19.6 months.

At the beginning of therapy, systolic and diastolic blood pressures were lower in patients with oliguria than in patients without oliguria ($p<0.001$), but C-reactive protein ($p=0.004$) and ferritin ($p<0.001$) levels were higher. There was no difference between two groups regarding the other parameters (age, follow-up periods, presence of diabetes, ultrafiltration volumes, albumin, hemoglobin, calcium phosphorus product, parathormone, and Kt/V levels) ($p>0.05$).

The peritonitis rate was one episode per 28.2 versus 30 patient-months for the anuric and non-anuric groups, respectively ($p>0.05$).

For Kaplan–Meier survival analysis, the mean technique survival rates at 1 and 3 years were 97% and 86.6% in patients without anuria and 94% and 85.3% in patients with anuria, respectively. The 5-year technique survival rates according to residual volume states were not statistically significant with log-rank test ($p>0.05$).

The 1-, 3-, and 5-year survival rates were 96.9%, 89.6%, and 86.5% in patients without anuria, respectively, whereas they were 87.3%, 77.3%, and 53.7% in patients with anuria, respectively. The 5-year survival rates according to residual volume states were statistically significant ($p<0.05$).

Conclusion: RRF at the beginning of PD has an important and positive impact on patient survival in PD patients. Peritonitis rates and technique survival were not different for patients with anuria and without anuria.

Keywords: Patient survival; peritoneal dialysis; residual renal function; technique survival.

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Residual renal function (RRF) is accepted as a rescuer in patients with end-stage renal disease (ESRD) by many nephrologists. Many published studies regarding RRF preservation are in favor of peritoneal dialysis (PD) compared with hemodialysis (HD).[1, 2] Increased biocompatibility of PD solutions and similarity of PD physiology to normal kidney as PD continues 24 h/day are the main speculations for better protection of RRF in PD.

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PD adequacy and volume control are two main factors affecting patient survival. Reanalysis of the Canada–USA (CANUSA) data revealed that preserving RRF contributes more on volume control rather than small solute clearance.[3] In addition, some other studies revealed that the maintenance of RRF improves not only volume control but also phosphorus level, nutrition parameters, valvular calcification scores, and cardiac hypertrophy.[4–6]

Regarding previous studies, the present study aimed to evaluate the relationship between urine output and patient and technique survival in PD patients.

Methods

A total of 218 patients who have started PD between 2000 and 2010 at our nephrology clinic in Istanbul, Turkey were enrolled in the study. Sixteen patients were excluded from the study due to discontinuation of PD treatment within the first 3 months. Finally, data of 202 patients were evaluated retrospectively.

Informed consent was obtained from all participants. Ethical approval was not applied because of the retrospective design of the study.

Demographic characteristics and baseline data including age, gender, etiology of ESRD, body mass index (BMI), presence of diabetes mellitus, hepatitis B and C status, HD history and its duration, and clinical records of the patients were reviewed. Adequacy of dialysis, peritoneal transport status, and biochemical results were recorded at the beginning of PD. Blood pressure and peritonitis episodes were also recorded. Death, transfer to HD, and kidney transplantation were the other noted parameters.

Patients were categorized into two groups based on daily urine outputs as anuric (≤100 ml/day) and non-anuric (>100 ml/day) at the time of PD initiation. There were 58 patients with anuria and 144 patients without anuria.

The two groups were compared according to demographic, clinical, and laboratory parameters including albumin, C-reactive protein (CRP), hemoglobin (Hb), calcium phosphorus product, intact parathyroid hormone (iPTH), ferritin, total Kt/V, peritonitis incidence, and patient and technique survival. Technique failure was defined as transfer to HD due to the following reasons: peritonitis, ultrafiltration failure, inadequate dialysis, exit site and/or tunnel infection, and mechanical problems.

BMI was calculated as weight (kg) divided by square of height (m). Blood sample was extracted before the morning exchange in fasting state. Serum calcium, phosphorus, creatinine, and albumin were measured by an autoanalyzer. The immunonephelometric method was used to determine serum CRP. The limit for the reported values of CRP was 8 mg/l. Two-site chemiluminescent enzyme immunometric method assay on an immulite automatic analyzer was used to determine the iPTH levels.

The peritoneal equilibration test was performed according to the Twardowski method.[7] Two liters of 2.27% glucose concentration fluid for a 4-hour dwell period was used.

Statistical Analysis

Statistical Package for the Social Sciences (version 11.0; SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Nonparametric variables were compared by chi-square test. Comparison of clinical and biochemical parameters between the anuric and non-anuric groups was made by independent-samples T test. The Kaplan–Meier method was used to define patient survival rate and technique survival rate. Comparison of outcomes was performed by log-rank test. Risk factors affecting patient mortality and their hazard ratio were determined by the logistic regression model. A p value <0.05 was considered statistically significant.

Results

The number of female patients was 106. The mean age of the patients was 43.4±14.6 years, and the mean follow-up time was 40.9±28.9 months. Table 1 shows the baseline demographic characteristics of the patients.

Table 1. Baseline characteristics of all patients

Patients (n)	202
Mean age (years)	43.4±14.6
Gender (female/male)	106/96
Mean follow-up period (months)	40.9±28.9
Causes of ESRD, n (%)	
Chronic glomerulonephritis	26 (12.9)
Diabetic nephropathy	29 (14.3)
Hypertension	15 (7.4)
Others	35 (17.3)
Unknown	97 (48)
Comorbid conditions, n (%)	
Diabetes mellitus	29 (14.3)
Coronary artery disease	8 (4.0)
Congestive heart failure	3 (1.5)
Hepatitis B and/or C	8 (4)
Modality, n (%)	
APD	57 (28.2)
CAPD	145 (71.8)
Baseline PD adequacy and urine volume	
Total Kt/V	2.2±0.5
Residual urine volume (ml/day)	422±460

APD: Automated peritoneal dialysis; CAPD: Continuous ambulatory peritoneal dialysis; ESRD: End-stage renal disease; PD: Peritoneal dialysis.

Fifty-eight patients had anuria, and 144 patients had no anuria at the beginning of dialysis. Table 2 shows the comparison of two groups. Continuous ambulatory PD (CAPD) was the modality in 42 patients with anuria. Moreover, 27 patients with anuria had a history of HD before PD. In the non-anuric group, 41 patients received automated PD (APD). HD history before PD was present in 23 patients. The number of patients with anuria was 65 (45 CAPD and 20 APD) after a mean of 22.5±19.6 months of PD therapy.

By comparative analysis, sex distribution was statistically different in two groups (p=0.018). Patients with anuria had longer HD therapy before PD. CRP and ferritin levels were statistically higher, whereas systolic and diastolic blood pressures were statistically lower in patients with anuria than in those without anuria (Table 2). The peritonitis rates were similar in two groups.

In the Kaplan–Meier analysis of all patients, the 1-, 3-, and 5-year survival rates were found to be 94.1%, 87.2%, and 80.5%, respectively (Fig. 1). The mean survival time was 113.8±4.4 months. The mean survival time was 114.6±3.9 months, and the technical survival rates at 1, 3, and 5 years were 97.8%, 87.3%, and 78.6%, respectively.

The mean survival time for patients without anuria was 108.6±3.3 months, whereas it was 97.8±8.2 months for the anuric ones (log-rank p=0.002).

The 1-, 3-, and 5-year survival rates of the non-anuric group were 96.9%, 89.6%, and 86.5%, respectively, whereas the survival rates of patients with anuria were 87.3%, 77.3%, and 53.7%, respectively (Fig. 2).

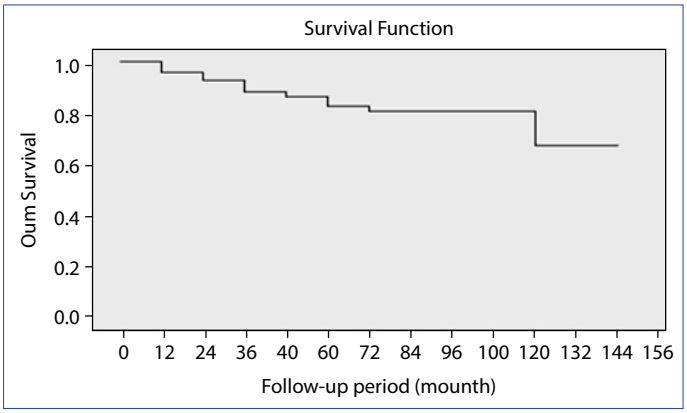

Figure 1. Survival rate of all patients. Kaplan Meier survival curve regarding all patients is given.

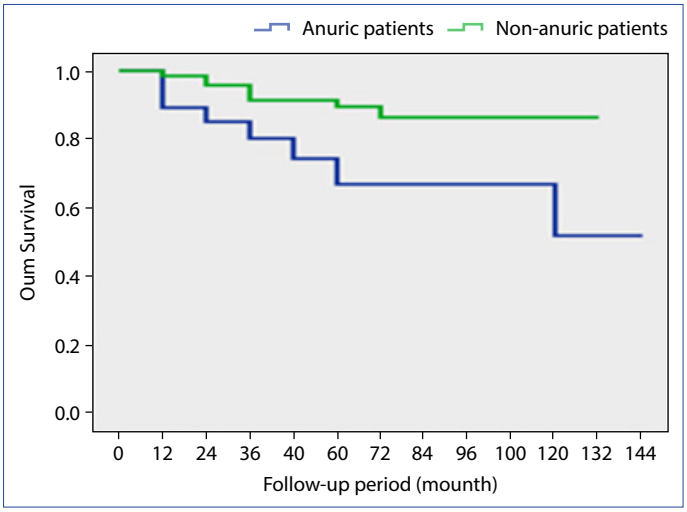

Figure 2. Survival rate of patients with anuria and without anuria. Survival of patients without anuria is better than that of patients with anuria.

Table 2. Comparison of patients with anuria and without anuria

	Anuric patients (n=58)	Patients without anuria (n=144)	p
Age (years)	42.8±14.9	43.7±14.4	n.s.
Gender (female/male)	38/20	68/76	0.018
Presence of diabetes mellitus	7	22	n.s
Body-mass index (kg/m^2)	24.4±6.9	23.5±4.26	n.s
Mean follow-up period (months)	44.2±35.0	39.6±26.1	n.s.
HD duration(months)	19.9±35.9	1.3±19.9	<0.001
UF volume (ml/day)	1053±408	1000±459	n.s.
Albumin (g/dl)	3.69±0.58	3.67±0.63	n.s.
CRP (mg/l)	21.5±31.9	18.7±30.2	0.004
Hemoglobin (g/dl)	11.4±2.5	10.8±1.7	n.s.
Ca x P product (mg/dl)	46.7±17	45.7±14.4	n.s
iPTH (pg/ml)	343±363	447±419	n.s.
Ferritin (ng/ml)	535±529	298±356	<0.001
Systolic BP (mmHg)	105.7±27.3	120.6±25.8	<0.001
Diastolic BP (mmHg)	67.9±16.1	78.5±15.9	<0.001
Peritonitis rate (episode per patient month)	1/28.2	1/30	n.s.

BP: Blood pressure; Ca: Calcium; CRP: C-reactive protein; HD: Hemodialysis; iPTH: intact parathyroid hormone; P: Phosphorus; UF: Ultrafiltration.

The mean technique survival rates were 100.6±3.8 months in patients without anuria and 116.6±7.13 months in patients with anuria (log-rank p=0.756). The technique survival rates at 1 and 3 years were 97.6% and 86.6%, respectively. The last obtainable technical survival at 56 months was 77.8% in patients without anuria. The technique survival rates at 1 and 3 years were 94.1% and 85.3%, respectively, whereas the last obtainable technical survival at 54 months was 80.6% in patients with anuria. The two groups had similar technical survival rates (Fig. 3).

To investigate the factors associated with mortality, the Cox regression analysis was performed in a model consisting of age, gender, residual urine volume, HD preceding PD, presence of diabetes mellitus, pretreatment serum albumin level, CRP level, and Hb level. It was found that CRP level, Hb level, age, serum albumin level, and residual urine volume were independent determinants of mortality (Table 3).

During the follow-up period, 26 (12.9%) patients had died. Reasons for death were cardiovascular causes in 9 patients, peritonitis in 7 patients, infection other than peritonitis in 1 patient, malnutrition in 2 patients, inadequate small solute clearance in 2 patients, and unknown causes in 5 patients. Twenty-seven (13.4%) patients experienced death-censored technique failure (i.e., transfer to HD), and 15 (7.4%) patients had renal transplantation.

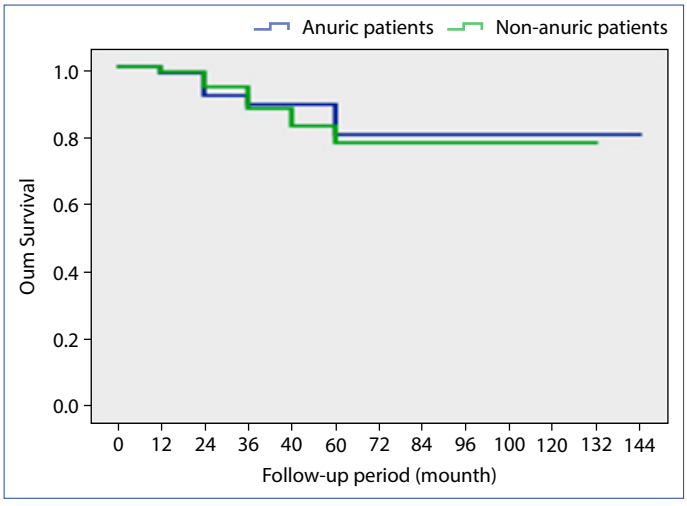

Figure 3. Technique survival of patients with anuria and without anuria. Two groups had similar technique survival rates.

Table 3. Independent prognostic factors on patient survival found by using multivariate time-dependent Cox regression model

	RR	95% CI	p
Age	1.099	1.061-1.139	0.000
Serum albumin	0.081	0.034-0.188	0.000
CRP	1.020	1.008-1.032	0.001
Hemoglobin	1.709	1.199-2.435	0.003
Residual volume	0.325	0.112-0.941	0.038

CRP: C-reactive protein.

Discussion

The present study shows that RRF has a great effect on patient survival in PD patients, but technique survival was not different in patients with anuria and without anuria.

RRF preservation is accepted as a predictor per patient survival on both PD and HD. Shemin et al.[8] showed lower mortality risk in HD patients in whom RRF was preserved. Analysis of paramount number of HD patients revealed that each increase of 1/week in renal Kt/V was associated with 56% decrease in death risk.[9] Hu et al.[10] showed that rapid RRF decline over a 12-month period is associated with increased risk of death more than double and doubled incidence of anuria.

RRF will decrease generally after 3–5 years of PD treatment.[4] It decreased from 3.8 ml/min to 1.4 ml/min with 2 years of mean follow-up period in the CANUSA study.[3] A previous study revealed that the mean duration to anuria is 51±25 months in the PD cohort.[11]

A study performed in PD patients by Lameire et al. showed that RRF is responsible to only 5% of the overall clearance after 5 years of PD, whereas it was 28% at first.[12] Factors affecting better protection of RRF were determined as male gender, higher baseline RRF, higher systolic blood pressure, biocompatible PD solution, lower peritoneal ultrafiltration, and lower dialysate glucose concentration.[13]

Rocco et al. studied the 1-year mortality and factors affecting mortality on 1219 PD patients. They reported that RRF, lower serum albumin level, older age, and presence of diabetes mellitus as the cause of renal failure are the factors affecting 1-year mortality.[14] Shemin et al.[15] showed that PD patients having weekly renal creatinine clearance above the median level have decreased death rate. The survival advantage of preserving RRF in both PD and HD patients was shown by Van Der Wal.[16] Some additional reports about the importance of preserved RRF in the PD cohort are also available.[17–21]

Similar to other studies, we have found that survival of patients without anuria was better than that of patients with anuria with PD. Factors affecting mortality were age, serum albumin, and CRP and Hb levels. The cause of death in our dialysis population was similar to other reported series.[22–24] The most common causes of death were peritonitis and cardiovascular diseases in both groups.

Technique failure rates were similar in our study in contrary to reanalysis of the CANUSA[3] and Netherlands Cooperative Study on the Adequacy of Dialysis[9] data in which preserved

RRF was associated with a more favorable technique survival.

Twardowski et al.[25] reported that they have an impression that patients with a large body size tend to quit PD more when their RRF has decreased. It can be speculated that inadequate small solute clearance is the main problem when RRF decreases in patients with a large body size. The low BMI in our cohort may explain the unexpected low frequency rate of inadequate dialysis in our anuric of more exchanges to obtain enough clearance group.

Han et al.[26] and Perez et al.[27] reported RRF reduction as an independent risk factor for peritonitis. Even though the underlying reason is unclear, poor nutritional condition and decreased immunity due to ESRD may be the possible reasons for this condition.[28, 29] Moreover, an increasing need to do more exchanges to obtain enough adequacy after RRF reduction may increase the risk of infection.

Both groups had similar peritonitis rate in our study, which was not the case in similar published studies. Presence of diabetes and low serum albumin levels are frequent factors increasing infection rate. Our similar infection rate may be due to similar diabetes and serum albumin levels between two groups.

The leading cause of accelerated atherosclerosis in dialysis patients is inflammation.[30–32] A previous study accepted CRP as an inflammatory marker and found the incidence of inflammation as 36%.[33] A significant relationship between CRP and RRF in PD patients was shown by Chung et al.[34] We also found higher CRP and ferritin levels in patients with anuria, which was thought as a result of increased inflammation in this group.

We found that systolic and diastolic blood pressures were lower in the oliguric patient group than in the non-oliguric patient group. Similarly, Cheng et al. found that although more fluid and sodium was removed from RRF preserved patients, there is no difference in extracellular fluid volume. Moreover, they had higher mean blood pressure. We believe that the significant difference between the blood pressures may be explained by the duration of HD therapy preceding PD.

The limitations of the present study are its retrospective design and reflection of experience limited to one center. These confounding factors might have affected our findings.

In conclusion, our study demonstrates that preserved RRF at the initiation of PD has a beneficial effect on patient survival with similar technique survival and infection rate compared with patients without urine. Moreover, a low initial RRF is associated with more inflammation and increased mortality. These results underline the importance of RRF on mortality in PD patients. Efforts to preserve RRF should be performed.

Disclosures

Ethics Committee Approval: Ethical approval was not taken due to retrospective design of the study.

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship contributions: Concept – E.A.; Design – E.A.; Supervision – M.S.; Materials – E.A.; Data collection &/or processing – E.A.; Analysis and/or interpretation – E.A., M.S.; Literature search – E.A.; Writing – M.S.; Critical review – E.A., M.S.

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