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Original Article

Clinical significance of red blood cell distribution width in the prediction of mortality in patients on peritoneal dialysis

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Abstract

Background: In this study, we assessed whether red blood cell distribution width (RDW) was associated with all-cause mortality in patients on peritoneal dialysis (PD) and evaluated its prognostic value.

Methods: This study included 136 patients who had RDW levels at PD initiation from January 2007 to January 2014 at the Presbyterian Medical Center and Seoul St. Mary's Hospital. We divided these patients into 2 groups (survivors vs. non-survivors), compared their clinical characteristics, and analyzed the predictors of survival.

Results: The study included 79 men and 57 women, with a mean age of 54 years (range, 15–85 years). The mean follow-up duration was 32 months (range, 1–80 months). Of 136 patients, 14 died during the follow-up period. When clinical characteristics of survivors ($n = 122$) and nonsurvivors ($n = 14$) were compared, no differences were identified, with the exception of serum albumin, total iron-binding capacity (TIBC), left ventricular ejection fraction, total leukocyte count, and RDW value. Survivors had higher serum albumin (3.4 ± 0.5 vs. 3.0 ± 0.5 g/dL, $P < 0.001$) and left ventricular ejection fraction (56.8 ± 9.8 vs. 48.7 ± 12.8, $P = 0.040$) and lower TIBC (213.4 ± 40.9 vs. 252.8 ± 65.6, $P = 0.010$), total leukocyte counts ($6.9 \times 10^3/\mu L$ vs. $8.6 \times 10^3/\mu L$, $P = 0.009$), and serum RDW values (13.9 ± 1.7 vs. 16.0 ± 1.8, $P < 0.001$). Patients with high RDW levels (≥ 14.8) showed significantly higher all-cause mortality than patients with low RDW levels (< 14.8, $P < 0.001$). In multivariate-adjusted Cox analysis, RDW and TIBC at the start of PD were independent risk predictors for all-cause mortality.

Conclusion: RDW could be an additive predictor for all-cause mortality in patients on PD.

Introduction

Red blood cell distribution width (RDW) is an index measurement of erythrocyte volume variability and is routinely reported as a part of a complete blood cell count [1,2]. Elevated

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RDW reflects increased size variations of red blood cells, which indicates altered erythrocyte life span or dysfunctional erythrocytes. For a long time, RDW has been regarded as a useful index to differentiate the etiology of anemia, such as thalassemia and megaloblastic anemia, as well as iron deficiency–related anemia [3].

In recent years, it was observed that high RDW levels were associated with an increased risk of adverse outcomes in the general population [4], severe sepsis [5], heart failure [6], coronary artery disease [7], stroke [8], acute kidney injury that required renal replacement therapy [9], and kidney transplant recipients [10]. In addition, it was reported that high RDW is associated with early failure of arteriovenous fistula for hemodialysis access [11]. The exact mechanisms causing elevated RDW in these diverse conditions are unknown; however, it is assumed to be related to inflammatory processes that might interfere with the process of erythropoiesis [12]. A few authors reported that increased RDW is a predictor of mortality in end-stage renal disease (ESRD) patients [13,14].

However, there are only a few studies that have investigated the association between RDW and adverse outcomes in patients on peritoneal dialysis. Therefore, we investigated the association between increased RDW and all-cause mortality in patients on peritoneal dialysis (PD).

Methods

Patient selection

Between 2007 and 2014, 458 patients received PD as a renal replacement therapy at the Presbyterian Medical Center and Seoul St. Mary's Hospital. Therefore, 136 patients were included in this study and were divided into 2 groups: survival ($n = 122$) and nonsurvival ($n = 14$). This study was approved by the institutional review boards of the Presbyterian Medical Center and Catholic University of Korea.

Clinical and laboratory information

The patients' baseline demographics as well as clinical and laboratory data were reviewed at the start of PD. The reference range for RDW levels in this study was 12.2–14.8%. The primary end point was all-cause mortality and the secondary end point was nonfatal cardiovascular (CV) events. CV events were defined as coronary artery disease (coronary artery bypass surgery, percutaneous intervention, or myocardial infarction), heart failure, ventricular arrhythmia, cerebrovascular accidents (cerebral infarction, transient ischemic attack, or cerebral hemorrhage), or peripheral arterial disease.

Statistical analysis

All the data are presented as the mean ± standard deviation unless otherwise specified. Comparisons of continuous variables between groups were carried out using the Wilcoxon–Mann–Whitney test. Comparisons between groups for categorical variables were carried out using the chi-square test. Kaplan–Meier curves and log-rank tests were used to describe and compare the event-free survival rates for all-cause mortality. Prognostic variables for mortality were analyzed by using the univariate Cox proportional hazards model, and variables with $P < 0.1$ in univariate analysis were used in the multivariate Cox proportional hazards model. The univariate and multivariate Cox regression analysis results are presented as hazard ratios and 95% confidence intervals. A P value of < 0.05 was considered statistically significant. Statistical analysis was carried out using SPSS software, version 21 (IBM corporation, New York, NY, USA).

Results

Baseline characteristics

The study included 79 (58%) men and 57 (42%) women, with a mean age of 54 years (range, 15–85 years). Sixty-nine patients had diabetes. The initial hemoglobin and mean RDW levels were 8.9 g/dL and 14.2%, respectively. The serum albumin was 3.3 g/dL. One hundred twenty-two patients (90%) received erythropoiesis-stimulating agents. During the mean follow-up of 32 months (range, 1–80 months), 14 deaths (9%) and 18 nonfatal CV events (14%) occurred.

Comparison of clinical characteristics between survivors and nonsurvivors

Survivors had higher serum albumin (3.4 ± 0.5 vs. 3.0 ± 0.5 g/dL, $P < 0.001$) and left ventricular ejection fraction (LVEF; 56.8 ± 9.8 vs. 48.7 ± 12.8, $P = 0.040$) and lower total iron-binding capacity (TIBC; 213.4 ± 40.9 vs. 252.8 ± 65.6, $P = 0.010$), total leukocyte counts ($6.9 \times 10^3/\mu L$ vs. $8.6 \times 10^3/\mu L$, $P = 0.009$), and serum RDW values (13.9 ± 1.7 vs. 16.0 ± 1.8, $P < 0.001$) than nonsurvivors (Table 1).

Table 1. Comparison of baseline characteristics between survivors and nonsurvivors

	Survivors ($N = 122$)	Nonsurvivors ($N = 14$)	P
Age (y)	54.0 ± 12.0	58.0 ± 12.0	0.342
Male	74 (61)	5 (39)	0.301
Duration of dialysis (mo)	34.0 ± 23.0	15.0 ± 21.0	0.007
Diabetes	62 (51)	7 (50)	0.592
Previous CV disease	6 (5)	1 (7)	0.540
RDW (%)	13.9 ± 1.7	16.0 ± 1.8	< 0.001
Hemoglobin (g/dL)	9.0 ± 1.8	9.5 ± 1.4	0.421
Ferritin (ng/mL)	360.4 ± 333.8	571.2 ± 808.9	0.138
Iron (μg/dL)	67.5 ± 31.3	58.5 ± 25.9	0.380
TIBC (μg/dL)	213.4 ± 40.9	252.8 ± 65.6	0.010
Erythropoietin-stimulating agent	109 (89)	13 (93)	0.260
Total leukocyte count ($\times 10^3/\mu L$)	6.9 ± 2.2	8.6 ± 3.6	0.009
Platelet ($10^3/\mu L$)	191.0 ± 74.0	227.0 ± 92.0	0.140
C-reactive protein (mg/dL)	1.3 ± 2.3	2.4 ± 4.1	0.142
Intact PTH (pg/mL)	320.3 ± 420.3	296.4 ± 337.6	0.349
Albumin (mg/dL)	3.4 ± 0.5	3.0 ± 0.5	< 0.001
Total cholesterol (mg/dL)	160.0 ± 52.0	166.0 ± 60.0	0.680
Triglyceride (g/dL)	170.0 ± 200.0	136.0 ± 63.0	0.521
Na (mEq/L)	138.3 ± 3.6	136.5 ± 3.3	0.156
CO_2 (mEq/L)	21.4 ± 5.4	23.3 ± 3.4	0.192
Echocardiographic data*			
LA diameter (mm^2)	40.6 ± 11.0	44.6 ± 2.7	0.561
LV ejection fraction	56.8 ± 9.8	48.7 ± 12.8	0.040
E/E′ ratio	13.7 ± 5.6	16.6 ± 9.7	0.213

Data are presented as means ± SD or number (%).
* Echocardiographic data were available in 99 patients.
CV, cardiovascular; LA, left atrium; LV, left ventricular; PTH, parathyroid hormone; RDW, red blood cell distribution width; TIBC, total iron-binding capacity.