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The relationship between renal resistive index and simple hematologic indices in patients with chronic kidney disease

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ABSTRACT

Introduction: The renal resistive index (RRI) in Doppler ultrasonography is a useful marker for measuring the blood flow changes in kidney diseases as well as showing tubulointerstitial damage. Although there have been many studies on the relationship between RRI increase and kidney damage, only a few provide information on RRI and inflammation markers. This study aimed to compare RRI with blood inflammatory markers derived from hemogram in patients with chronic kidney disease (CKD).

Material and Method: Ninety (33 female, 57 male) CKD patients who followed up at a nephrology clinic between January 2017 and December 2018 were included in this retrospective study. The RRI, serum creatinine, C-reactive protein (CRP), complete blood count results, leukocyte count (WBC), neutrophil to lymphocyte ratio (NLR), monocyte or lymphocyte (MLR), platelet to lymphocyte ratio (PLR), mean platelet volume (MPV) and red cell distribution width (RDW) values of each patient were recorded. The eGFR was calculated with a CKD-EPI formula. Nonparametric tests were used to compare age, gender, RRI, biochemistry and hemogram values for the study patients.

Results: The mean age of the patients was 55.24±14.35 years. Regarding the comparison of the RRI with age and serum CRP, a statistically significant positive relationship was found (r=.398, p<.001; r=.365, p<.001, respectively). The mean eGFR was found to be 42.47±26.57 ml/min/1.73 m^2. A statistically significant negative correlation was found between the RRI and the eGFR (r=-.312, p=.003). When the RRI was compared with the WBC and the PLR, no statistically significant relationship was found (p=.229, p=.45, respectively). However, statistically significant positive relationships were found when the RRI was compared to the NLR and the MLR, a (r=.259, p=.014/r=.228, p=.031, respectively). Additionally, there was a statistically significant positive relationship between the RRI and the RDW (p<.001, r=.383). In contrast, there was no relationship between the MPV and the RDW (p>.05).

Conclusions: The negative relationship between the RRI and the eGFR in CKD patients show that the resistive index may determine the level of renal damage.

Keywords: Renal resistive index, simple hematologic indices, chronic kidney disease

INTRODUCTION

Chronic kidney disease (CKD) is a chronic inflammatory process (1). Many factors such as increased pro-inflammatory cytokines, oxidative stress, acidosis and recurrent infections contribute to chronic inflammation in CKD patients (2). Chronic inflammation affecting tubulointerstitium increases nephron loss (3). A renal resistive index (RRI) of Doppler ultrasonography is a useful parameter for measuring blood flow changes in kidney diseases and can show damage in tubulointerstitium (4). A renal resistive index can be used in the early diagnosis of chronic tubulointerstitial nephritis in patients with preserved kidney function (5). An increased serum C-reactive protein (CRP) level has been reported in CKD when compared to healthy individuals (6,7). Mean platelet volume (MPV), the neutrophil to lymphocyte ratio (NLR) and the platelet to lymphocyte ratio (PLR) increase during chronic inflammation (8-10). The monocyte to lymphocyte ratio (MLR) is an independent predictor for risk of CKD (11). The red cell distribution width (RDW) elevates during oxidative stress, inflammation, malnutrition, dyslipidemia and hypertension (12). There have been a limited number of studies in the literature comparing the RRI with inflammatory serum markers in CKD (13). The purpose of our study was to investigate whether there would be a relationship between the RRI and serum inflammatory markers in CKD patients.

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MATERIAL AND METHOD

The study was carried out with the permission of Çanakkale Onsekiz Mart University Clinical Research Ethics Committee (Permission granted 13.03.2019 Decision No. 2019-06).

In this retrospective study, the medical records of the patients that presented to the nephrology clinic of Çanakkale Onsekiz Mart University, Medical Faculty Hospital hospital between January 2017 and December 2018 were examined. Patients with CKD whose ages were between 18 and 80 years were included in the study. Patients with an age of fewer than 18 years or more than 80 years and patients with active signs of infection, chronic systemic disease history that could effect the CRP value and malignities at the time of the RRI measurement were excluded from the study. Blood was taken in vacuum gel tubes for CRP measurement. CRP was analyzed using the nephelometric method. The RRI measurement of each patient was obtained by a radiology specialist using a doppler USG device for recording. The RRI value was determined according to an average of three different measurements obtained as a result of examining the interlobar artery in the upper, middle and lower regions of the kidney. A Toshiba Aplio XG doppler USG device was used with a convex transducer (PVT-375BT) for the determination of the RRI value. The RRI value was calculated by using the following formula: "peak systolic velocity-end-diastole velocity/peak systolic velocity" (4). The complete blood count was examined with a Beckman Coulter LH-780 (Beckman Coulter Ireland Inc Mervue, Galway, Ireland). In CKD patients, the eGFR measurement was determined with the CKD-EPI formula (14).

Statistical Analysis

The data from this research was electronically transferred to the SPSS 20.0 statistics program, and data control and analysis were performed. In evaluating the normal distribution of data, Kolmogorov-Smirnov test was used. The average, standard deviation, median, minimum and maximum values were used to evaluate continuous variables. A Spearman correlation analysis was used to compare the markers examined for statistical evaluation. The $p<.05$ value was accepted as proof of statistical significance.

RESULTS

Ninety CKD patients (33 females, 57 males) were included in this study. The demographic features and serum markers of the patients are shown in **Table 1**. Statistically significant positive correlations were found between the RRI of CKD patients and age, as well as serum CRP level ($r=.398$, $p<.001$; $r=.365$, $p<.001$, respectively). Conversely, a statistically significant negative correlation was found between the RRI and the eGFR ($r=-.312$, $p=.003$). Additionally, there was a statistically significant positive relationship between the RRI and the NLR ($r=.259$, $p=.014$). When the RRI and the MLR were compared, a statistically significant positive relationship was further found ($r=.228$, $p=.031$). There was no statistically significant relationship between the RRI and the MPV or the RRI and the PLR ($p=.141$, $p=.45$, respectively). There was a statistically significant positive relationship between the RRI and the RDW ($r=.383$, $p<.001$). The relationship between renal resistive index and hematologic parameters of the patients are shown in **Table 2**.

Table 1. Demographic findings and serum markers of patients

Demographic findings and serum markers	Mean±standard deviation	Median (min-max)
Age (years)	55.24±14.35	55.5 (26-79)
RRI	0.70±0.09	0.70 (0.50-0.85)
Serum creatinine (mg/dL)	2.09±1.26	1.8 (0.6-9.0)
eGFR (mL/min/1.73 m^2)	42.47±26.57	35.5 (5-127)
Serum uric acid (mg/dL)	6.41±1.8	6.1 (1.2-11.0)
Serum albumin (g/dL)	4.24±0.65	4.3 (2.3-5.4)
Serum CRP (mg/dL)	1.79±2.92	0.6 (0.1-16.5)
Serum total cholesterol (mg/dL)	180.5±43.1	166 (110-328)
Serum triglyceride (mg/dL)	158.6±76.2	130 (45-449)
WBC (mm^3)	8133±2654	8065 (1260-17240)
Hemoglobin (g/dL)	11.89±2.24	12.0 (6.4-16.7)
PLT (mm^3)	258500±95348	241000 (59000-528000)
MPV (fL)	8.57±1.35	8.4 (6.4-15.5)
RDW	15.16±2.16	15 (12-23)
NLR	7.12±9.13	4.15 (0.7-55.33)
PLR	357.78±475.54	199.45 (36.3-2677.8)
MLR	0.67±0.73	0.42 (0.04-5.1)

RRI, renal resistive index; eGFR, estimated glomerular filtration rate; WBC, white blood cell; PLT, platelet count; MPV, mean corpuscular volume; RDW, red blood cell distribution width; NLR, neutrophil lymphocyte ratio; PLR, platelet lymphocyte ratio; MLR, monocyte lymphocyte ratio.

Table 2. The relationship between renal resistive index and hematologic parameters

	RRI	
Hematologic parameters	**r**	**p**
WBC	0.129	0.229
Hemoglobin	-0.225	0.034
PLT	-0.87	0.419
MPV	-0.157	0.141
RDW	0.383	<0.001
Neutrophil	0.150	0.160
Lymphocyte	-0.126	0.259
Monocyte	0.118	0.271
NLR	0.259	0.014
MLR	0.228	0.031
PLR	0.081	0.450

RRI, renal resistive index; WBC, white blood cell; PLT, platelet count; MPV, mean corpuscular volume; RDW, red blood cell distribution width; NLR, neutrophil lymphocyte ratio; PLR, platelet lymphocyte ratio; MLR, monocyte lymphocyte ratio.

Regarding the serum CRP of CKD patients, statistically significant correlations were determined between the CRP and the NLR, PLR, MLR and RDW ($p<.05$). However, no statistically significant relationship was found between the CRP and the MPV ($p=.258$).

DISCUSSION

In chronic kidney disease, the NLR, PLR, MLR, RDW, MPV and serum CRP increase relative to inflammation (6,8-11,13,15). In some studies, a positive correlation was found between the RRI and serum CRP in CKD patients (13,16). Apart from this study, we did not find other studies comparing the RRI with serum inflammatory markers such as the NLR, PLR, MLR, RDW and MPV in chronic kidney disease. In our study, we found a positive significant relationship between the RRI and the CRP, NLR, MLR, and RDW in CKD patients. In contrast, there was no association between the RRI and the PLR or between RRI and the MPV.

Chronic inflammation affects tubulointerstitium and increases nephron loss (3). The RRI has been found useful in chronic nephropathy and in demonstrating tubulointerstitial damage (4,5). In our study, we found a negative correlation between the RRI and the eGFR and a positive correlation between the RRI and age. This result was consistent with that of the literature (4,5,13). In end-stage renal failure, the elevation of serum hs-CRP is accompanied by an increase in the NLR and the PLR (10). In our study, the serum CRP levels of the patients were found to correlate positively with each of the other inflammatory markers, including the NLR, PLR, MLR and RDW and excluding the MPV.

In our study, we did not find a relationship between the serum CRP level and the MPV or between the RRI and the MPV in CKD patients. Although Yilmaz et al. (7) have reported an inverse correlation between the MPV and fibrinogen in stage 3–4 CKD patients, the authors have not shown an MPV increase in the case of disease progression. In patients with hypertensive CKD (stage 1–3), the PLR has not been demonstrated to have an impact on the progression of the disease (17). These findings suggest that an increase in the MPV and PLR may not be expected with the progression of CKD.

There were several factors that limited our study. Our retrospectively planned study included a limited number of patients. Body mass index, blood pressure measurement, serum glucose, fibrinogen, electrolytes and total protein in urine were not assessed simultaneously for patients. Additionally, a control group could not be included in this study.

CONCLUSION

In addition to determining the degree of vascular occlusion, the RRI can be useful when evaluating the chronic inflammatory response accompanying tubulointerstitial injury for CKD patients. Prospective studies are needed on this subject.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was carried out with the permission of Çanakkale Onsekiz Mart University Clinical Researchs Ethics Committee (Permission granted: 13.03.2019, Decision no. 2019-06).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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