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STATUS OF ERYTHROCYTE SEDIMENTATION RATE, RED CELL AND PLATELET INDICES IN PATIENTS WITH CHRONIC KIDNEY DISEASE IN OWERRI METROPOLIS, NIGERIA

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Abstract: Kidney disease is a condition where the kidneys are damaged and unable to function properly. This study was aimed at investigating the status of erythrocyte sedimentation rate, red cell and platelet indices in patients with chronic kidney disease in Owerri metropolis. A total of fifty (50) subjects who were 18 years and above were recruited for the study. Twenty five (25) patients with chronic kidney disease and twenty five (25) age-matched apparently healthy individuals (controls). Samples were collected aseptically, and prepared by standard methods prior to use. Estimation of Erythrocyte Sedimentation Rate (ESR) was done using Westergren method. Estimations of red cell and platelet indices were done using Bio Maxima BM HEM 3 automated hematology analyzer. This study showed that the mean value of ESR was significantly increased in patients with chronic kidney disease when compared to the healthy controls, while the mean values of MCV, MCH, MCHC, MPV, PCT and PDW were significantly reduced in patients with chronic kidney disease when compared to healthy controls (p=0.000 and 0.015). There was no significant difference in the mean values of RDW and PLT in patients with chronic kidney disease when compared to the healthy controls (p=0.857 and p=0.552). There was no significant difference in the mean values of ESR, MCV, MCH, MCHC, RDW, PLT, MPV, PCT and PDW in male patients suffering from kidney disease when compared to females (p=0.538, p=0.460, p=0.315, p=0.183, p=0.477, p=0.085, p=0.824, p=0.089 and p=0.230). The result clearly indicates that an increase in ESR correlates with a decrease in MCV and PDW. Kidney disease is associated with a significant increase in ESR and a decrease in MCV, MCH, MCHC, MPV and PCT.
Keywords: Red blood cell; Erythrocyte sedimentation rate; Chronic kidney disease; Red blood cell indices; Platelet indices

1 INTRODUCTION

Kidney disease (also called renal disease) is a general term for when the kidneys are damaged and do not function as they should. Chronic kidney disease has emerged as one of the leading causes of mortality worldwide, and one of a small number of non-communicable diseases that have shown an increase in associated deaths over the past 2 decades. Chronic kidney disease (CKD) is a progressive condition that affects >10% of the general population worldwide, amounting to >800 million individuals. It is more prevalent in older individuals, women, racial minorities, and in people experiencing diabetes mellitus and hypertension; and represents an especially large burden in low- and middle-income countries, which are least equipped to deal with its consequences [1].

Erythrocyte sedimentation rate (ESR) measures the ability of erythrocytes (red blood cell) to fall through the blood plasma and accumulate together at the base of container in one hour [2]. Erythrocyte sedimentation rate has been reported to be raised in conditions such as anemia, kidney failure, obesity, ageing, menstruation and pregnancy [2-3].

Red cell distribution width (RDW) measures the size variation of the circulating erythrocytes. Increased size variability of the erythrocytes is defined as anisocytosis, and demonstrated as high RDW values on blood count readings [4]. High RDW was found to be associated with adverse renal outcome, cardiovascular disease, and mortality in patients with chronic kidney disease [4-6].

Mean platelet volume (MPV) is a test that measures the size of the circulating platelets. Large platelets are generally younger with more reactive granules to induce adhesion and aggregation. Therefore, increased MPV was introduced as an indicator of platelet reactivity, atherosclerosis, and inflammatory status [7-8]. On the other hand, patients with severe inflammation and some patients with advanced chronic kidney disease have been reported to have low MPV levels [9-10].

The prevalence of chronic kidney disease (CKD), which has various side effects and is very expensive, is a global health concern [11]. For early detection, risk assessment, and customized care, it is essential to comprehend hematological alterations in CKD patients. Erythrocyte Sedimentation Rate (ESR), Red Cell Indices (RCIs), and Platelet Indices (PIs) are hematological measures that offer important insights into the disease stage, comorbidities, and prognosis. These variables can improve the ability to diagnose a condition, act as predictors of prognosis, and provide therapeutic advice. The findings may help doctors make treatment decisions by educating them about the hematological alterations linked to renal illness. By

learning more about the connections between hematological indices and kidney health, nephrologists, hematologists, and other medical specialists can receive knowledge that will help them make better clinical judgments and improve patient care. Understanding the hematological components of kidney disease can help with early detection and intervention, thereby decreasing the healthcare costs associated with advanced CKD and the rising prevalence of CKD in Owerri and even globally. This study is therefore aimed at investigating the status of erythrocyte sedimentation rate, red cell and platelet indices in patients with kidney disease in Owerri

2 MATERIALS AND METHODS

2.1 Study Area

The study was carried out at Federal University Teaching Hospital, Owerri, Imo State. It is located in Owerri Municipal. Owerri is bordered by Abia state on the East, River Niger and Delta state on the West, Anambra state on the North and Rivers state to the South.

2.2 Study Design

This was a cross-sectional, descriptive study involving the use of questionnaires and performing laboratory procedures using samples from study subjects.

2.3 Study Population

The study population was composed of 30 patients who were 18 years of age and above, with chronic kidney disease and whose kidney function had been ascertained by performing kidney function assays. An equivalent number of age-matched apparently healthy subjects were also included in the study and served as the controls.

2.4 Ethical Consideration

The research study was approved by the ethical review committee of Federal University Teaching Hospital, Owerri. Subjects who gave their informed consent were recruited for the study.

2.5 Method of Recruitment

The method of recruitment was through convenience sampling and administration of questionnaires. Patients were recruited consecutively from nephrology clinic of the hospital for the study and then a well-structured questionnaire, containing survey questions was used. The questionnaire had four sections (A to D) covering background characteristics of respondent, medical characteristics such as, medication, treatment, dietary and lifestyle.

2.6 Sample Collection

Five milliliters (5ml) of venous blood was collected aseptically from the subjects into vacutainer bottles containing ethylenediaminetetraacetic acid (K_2EDTA). 3ml was used for red cell indices and platelet indices using the Bio Maxima BM HEM 3 hematology analyzer, while 2ml was used for analysis of erythrocyte sedimentation rate by Westergren method using Sedivette tubes as recommended by International Council for Standardization of Hematology (ICSH) described in practical hematology edited by Lewis and Colleagues, and Cheesbrough.

2.7 Laboratory Procedures

The erythrocyte sedimentation rate (ESR) was performed using westergren method, while the red cell and platelet indices were done using automated hematology analyzer.

2.8 Statistical Analysis

Statistical package for the Social Sciences (SPSS) version 23.0 for Windows® (SPSS Inc., Chicago, IL, USA) was used to analyze the data. One Way Anova was used to analyze continuous variables. Statistically significant values were determined at 95% confidence level. Values were expressed as mean and standard deviation (Mean±SD) and results presented in tables.

3 RESULTS

The mean value of ESR (28.69±21.53)mm/hr was significantly increased in patients with chronic kidney disease when compared to the healthy controls (5.62±2.57) mm/hr (t=4.76, p=0.000). The mean values of MCV (77.56±8.21)fl, MCH

(23.45±3.74)pg and MCHC (28.80±1.38)g/dl were significantly reduced in patients with kidney disease when compared to the healthy controls (90.08±4.52)fl, (31.83±0.66)pg and (34.32±1.73)g/dl (t=6.20, p=0.000, t=9.87, p=0.000 and t=12.49, p=0.000). There was no significant difference in the mean value of RDW (13.52±4.05)% in patients with chronic kidney disease when compared to the healthy controls (13.69±0.84)% (t=0.18, p=0.857) (Table 1)

Table 1 Mean Value of ESR, MCV, MCH, MCHC and RDW in Patients with Kidney Disease Versus Controls (Mean±SD)

Parameter	Test n=30	Control n=20	t-value	p-value
ESR (mm/hr)	28.69±21.53	5.62±2.57	4.76	0.000*
MCV (fl)	77.56±8.21	90.08±4.52	6.20	0.000*
MCH (pg)	23.45±3.74	31.83±0.66	9.87	0.000*
MCHC (g/dl)	28.80±1.38	34.32±1.73	12.49	0.000*
RDW (%)	13.52±4.05	13.69±0.84	0.18	0.857*

KEY: ESR: Erythrocyte Sedimentation Rate; MCV: Mean Cell Volume; MCHC: Mean Cell Hemoglobin Concentration; RDW: Red cell distribution width; *: significant

The mean values of MPV (7.87±0.69)fl, PCT (0.17±0.07)% and PDW (9.86±1.90)% were significantly reduced in patients with chronic kidney disease when compared to the healthy controls (10.10±1.27)fl, (0.23±0.01)%, (11.29±2.08)% (t=8.04, p=0.000, t=3.79 p=0.000 and t=2.52, p=0.015).
There was no significant difference in the mean values of PLT (209.67±131.72) x109/L in patients with kidney disease when compared to the healthy controls (227.95±42.49) x109/L (t=0.59, p=0.552) (Table 2).

Table 2 Mean Value of PLT, MPV, PCT and PDW in Patients with Kidney Disease Versus Controls (Mean±SD)

Parameter	Test n=30	Control n=20	t-value	p-value
PLT ($x10^9$/L)	209.67±131.72	227.95±42.49	0.59	0.552
MPV (fl)	7.87±0.69	10.10±1.27	8.04	0.000*
PCT (%)	0.17±0.07	0.23±0.01	3.79	0.000*
PDW (%)	9.86±1.90	11.29±2.08	2.52	0.015*

KEY: *: significant: PLT: Platelet; MPV: Mean Platelet Volume; PCT: Plateletcrit; PDW: Platelet Distribution Width

There were no significant differences in the mean values of ESR (26.52±21.61)mm/hr, MCV (78.55±8.09)fl, MCH (23.06±3.99)pg, MCHC (29.10±1.27)g/dl, RDW (13.05±3.50)%, PLT (173.411±70.74) x109/L,MPV(7.84±0.76)fl,(0.15 ± 0.07)% and (10.23± 1.8)% in male chronic kidney diseased patients when compared to females (31.52±21.94)mm/hr, (76.27±8.51)fl, (22.65±3.37)pg, (28.42±1.47)g/dl, (14.14±4.76)%, (257.08±175.95) x109/L, (7.90±0.64)fl, (0.19±0.07)% and (9.38±1.89)% (t=0.62, p=0.538, t=0.75, p=0.460, t=1.02, t=0.72, p=0.315, t=1.79, p=0.183, t=0.17, p=0.477, t=0.23, p=0.824, t=1.76 p=0.089 and t= 1.23, p=0.230) (Table 3)

Table 3 Mean Value of ESR, MCV, MCH, MCHC, RDWC, PLT, MPV, PCT and PDW in Male Patients with Kidney Disease Versus Female Patients with Kidney Disease

Parameter	Male n=16	Female n=14	t-value	p-value
ESR (mm/hr)	26.52±21.61	31.52±21.94	0.62	0.538
MCV (fl)	78.55±8.09	76.27±8.51	0.75	0.460
MCH (pg)	23.06±3.99	22.65±3.37	1.02	0.315
MCHC (g/dl)	29.10±1.27	28.42±1.47	1.37	0.183
RDW (%)	13.05±3.50	14.14±4.76	0.72	0.477
PLT ($x10^9$/L)	173.41±70.74	257.08±175.95	1.79	0.085
MPV (fl)	7.84±0.76	7.90±0.64	0.23	0.824
PCT (%)	0.15±0.07	0.19±0.07	1.76	0.089
PDW (%)	10.23±1.88	9.38±1.89	1.23	0.230

KEY: *: significant; PLT: Platelet; MPV: Mean Platelet Volume; PCT: Plateletcrit; PDW: Platelet Distribution Width; ESR: Erythrocyte Sedimentation Rate; MCV: Mean Cell Volume; MCHC: Mean Cell Hemoglobin Concentration; RDW: Red cell distribution width

There was a significant negative relationship of ESR with MCV and PDW in patients with kidney disease , and a non-significant relationship with MCH, MCHC, RDWC, PLT and PCT in patients with kidney disease (r=-0.88, PCT (0.15±0.07)% and PDW (10.23±1.88)% in male patients with kidney disease (p=0.000 and r=-0.41, p=0.023) (Table 4).

Table 4 Correlation of the level of ESR with MCV, MCH, MCHC, RDW, PLT, MPV, PCT and PDW in Patient with Kidney Disease

Variable	N	r	p-value
MCV	30	-0.88	0.000*
MCH	30	0.34	0.064
MCHC	30	0.32	0.086
RDW	30	0.10	0.585
PLT	30	0.07	0.723
MPV	30	0.03	0.869
PCT	30	0.24	0.198
PDW	30	-0.41	0.023*

KEY: *: significant; PLT: Platelet; MPV: Mean Platelet Volume; PCT: Plateletcrit; PDW: Platelet Distribution Width; ESR: Erythrocyte Sedimentation Rate; MCV: Mean Cell Volume; MCHC: Mean Cell Hemoglobin Concentration; RDW: Red cell distribution width

4 DISCUSSION

Globally, chronic renal diseases which can progress to end-stage renal disease (ESRD) have emerged as a severe health concern [12]. The current study reveals that the mean value of ESR was significantly increased in patients with kidney disease when compared to controls. ESR is widely used as an indicator of acute-phase response in several immune-mediated inflammatory diseases, including breast cancer. The increase in ESR in kidney diseased patients reflects an inflammatory activation or an acute-phase response, accompanied by raised levels of circulating pro-inflammatory cytokines and their receptors, which in turns causes an increase in ESR. This observation is consistent with the findings carried out by Maradit-Kremers et al., (2017) [13], who stated that "disease activity in renal disease is assessed by examining symptoms of inflammatory disease, functional status and various laboratory tests of immune activation, such as erythrocyte sedimentation rate (ESR). Though they noted that the ESR is not diagnostic of any particular disease, it is an inexpensive and a practical indicator of response of acute phase proteins in plasma Beighton et al., (2015) [14].

The mean values of MCV, MCH, MCHC were significantly reduced in patients with kidney disease when compared to the healthy controls. Mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC) are used in the detection of anemia, a blood disorder characterized by a decrease in the total amount of red blood cells in the blood which in turn lowers the oxygen carrying capacity of the blood [15]. The decrease in MCV, MCH and MCHC might be as a result of lack of production of erythropoietin by the kidney. The kidney produces erythropoietin which plays an important role in red cell production, therefore chronic kidney disease causes anemia. The result of this study agrees with the report by Erken et al., (2020) [16], who stated that CKD is a condition that leads to anemia, endothelial dysfunction, systemic inflammation, malnutrition, and accelerated atherosclerosis, altogether, these conditions may affect the maturation of erythroid cell lines due to microvascular hypoxia and chronic cytokine exposure in the bone marrow and therefore affects the patients with advanced CKD.

From the result of the present study, there was no significant difference in the mean value of RDW in patients with kidney disease when compared to the healthy controls. Though the mean value of RDW was significantly higher in subjects suffering from chronic kidney disease in a study carried out by Zhang et al., (2017) [6]. They stated that the elevation in the RDW is a characteristic of anemia, which is as a result of a dysfunctional kidney. The result is also in agreement with the report by Erken et al., (2020) [16], who in their findings, observed a similar result. Factors such as sample size, treatment regimen of the patient might have been the reason behind the insignificant result recorded in this present study.

The mean values of PCT, MPV and PDW were significantly reduced in patients with kidney disease when compared to the healthy controls, but the mean PLT was not significantly reduced in patients with kidney disease compared to the controls. Habib et al., (2017) [17], in their study observed hyper destructive causes to be the major pathogenesis for the cause of low MPV, PLT, PCT, MPV and PDW. Relevant literature indicates the difficulties in elucidating the influence of multiple determinants on PLT and MPV in physiology and during disease state of the kidney, principally as a result of the differing factors affecting platelet reactivity [18]. Nevertheless, the evaluation of this aspect of MPV within clinical practice should be the subject of additional research.

In this study, it was observed that there was no significant difference in the mean values of ESR, red cell indices and platelet indices in male patients suffering from kidney disease when compared to the females. The result clearly shows that gender is not a predominant factor for determining if a patient will develop chronic kidney disease. The result of this study concurs with the study carried out by Shankar et al., (2014) [19], who reported a similar finding.

Lastly, there was a significant negative relationship of ESR with MCV and PDW in patients with kidney disease. The result clearly indicates that an increase in ESR correlates with a decrease in MCV and PDW.

5 CONCLUSION

Kidney disease is associated with a significant increase in erythrocyte sedimentation rate, coupled with a decrease in MCV, MCH, MCHC, MPV, PCT, PDW and PLT, and a significant negative relationship of ESR with MCV and PDW.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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