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Research Article

Status of Some Haematological and Biochemical Parameters in Patients Diagnosed with Chronic Kidney Disease at Imo State Specialist Hospital, Umuguma, Owerri, Nigeria

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Abstract
Chronic kidney disease (CKD) is a prevalent global health challenge characterized by the progressive deterioration of renal function leading to significant metabolic, haematological, and cardiovascular complications.This study was aimed at evaluating the levels of red cell distribution width (RDW), mean platelet volume (MPV), white blood cell (WBC), serum creatinine, urea and albumin in patients with chronic kidney disease at Imo State Specialist Hospital, Umuguma, Owerri, Nigeria. A total of sixty (60) subjects were enrolled in the study and consisted of thirty (30) patients with chronic kidney disease and 30 age-matched apparently healthy subjects (controls). Ethical approval and informed consent were obtained from the ethics committee of the hospital and subjects respectively. Venous blood (7mls) was collected from the patients by venipuncture using sterile needles and syringes and dispensed into plain tubes (5mls) and ethylenediaminetetraacetic acid (EDTA) containers (2mls) immediately. The non-haemolysed samples in the plain tubes were centrifuged and separated and the serum samples were stored at -20°C prior to use, while the blood in the EDTA container was stored in the refrigerator at 4 °C. All reagents were commercially procured and the manufacturer's standard operating procedures were strictly followed. Serum creatinine was determined using the Jaffe-Slot method, urea was determined using the diacetyl monoxime method, MPV and RDW and WBC were determined using haematology autoanalyser (Sysmex KX2IN while serum albumin was determined using the Bromocresol Green method. Values were presented as mean ± standard deviation (SD) and $p<0.05$ level of significance was adopted. All data obtained in the study were analyzed using the Statistical Package for Social Sciences (SPSS version 21). The mean values of urea (62.77±38.59)mg/dl, creatinine (2.72±2.27)mg/dl, RDW (52.12±8.42)fl, MPV (11.05±1.59)fl, WBC (10.25±4.02) cells/l were significantly in chronic kidney disease patients when compared to controls (18.10±6.08)mg/dl, (0.66±0.31)mg/dl, (43.46±8.97)fl, (8.63±0.93)fl and (5823.33±1969.89) cells/ul respectively ($P=0.000$) while albumin (3.34±0.93)mg/dl, was significantly lower when compared to controls (4.50±0.86)mg/dl ($P=0.000$). There was no significant difference in the mean values of urea (63.40±42.95)mg/dl, creatinine (3.09±2.85)mg/dl, albumin (3.05±0.77)mg/dl, RDW (52.1 l±6.78)fl, MPV (10.94±1.78)fl and WBC (10.40±4.59) cells/ul in males with chronic kidney disease when compared to that of the females (62.13±35.19)mg/dl, (2.34±1.49)mg/dl, (3.63±0.99)mg/dl, (52.13±10.04)fl, (11.17±1.44)fl and (10.09±3.52) cells/ul. There was no significant difference in the mean values of urea, creatinine, albumin, RDW, MPV and WBC in patients with chronic kidney disease when compared based on gender and age. There was a significant positive correlation of serum creatinine with urea in patients with chronic kidney disease ($r= 0.64$, $p=0.000$). There was a non- significant positive correlation of serum creatinine with albumin, RDW, MPV and WBC in patients with chronic kidney disease ($r= 0.08$, $p=0.683$; $r=0.23$, $p=0.228$; $r=0.05$, $p=0.808$ and $r=0.38$, $p=0.039$). Chronic kidney disease is associated with elevated levels of urea, creatinine, RDW, MPV, WBC and a significant decrease in albumin. Gender and age do not affect the levels of urea, creatinine, albumin, RDW, MPV and WBC in patients with chronic kidney disease. Therefore, we recommend that routine assessment of urea and creatinine should remain the cornerstone of CKD diagnosis and progression monitoring, and MPV, RDW and WBC should be assessed as part of cardiovascular risk evaluation, in routine blood tests for CKD patients to evaluate anaemia severity, and to detect systemic inflammation and its potential role in exacerbating CKD-related complications respectively.

Keywords: *Urea, Creatinine, Mean Platelet Volume, Red Cell Distribution Width, White Blood Cell, Chronic Kidney Disease.*

1. Introduction

Chronic Kidney Disease (CKD) is a growing global health concern, characterized by progressive loss of kidney function over a period of months to years. Early identification and management are crucial to slowing the disease progression and preventing complications, such as end-stage renal disease. A comprehensive understanding of biomarkers and laboratory parameters associated with CKD is essential for both diagnosis and monitoring. Various hematological and biochemical markers, including white blood cell count (WBC), mean platelet volume (MPV), red cell distribution width (RDW), urea, creatinine, and albumin, are increasingly being investigated for their potential role in assessing disease severity and prognosis in CKD patients.

White Blood Cell Count (WBC) plays a pivotal role in the immune response and has been shown to increase in chronic inflammatory conditions like CKD. Elevated WBC counts are often associated with systemic inflammation and endothelial dysfunction, which contribute to the cardiovascular morbidity observed in CKD patients (Shah, 2015). Moreover, increased WBC levels may reflect an exacerbation of kidney injury or the presence of comorbidities such as diabetes or hypertension, which are common among CKD patients (Kovacs et al., 2013).

Mean Platelet Volume (MPV) is a measure of platelet size, and an increase in MPV has been linked to platelet activation and a prothrombotic state. Research suggests that higher MPV levels are associated with adverse cardiovascular outcomes in CKD patients (Demir et al., 2016). MPV, alongside other platelet indices, may provide useful insight into the degree of platelet activation and its relationship with disease progression (Gupta et al., 2014).

Red Cell Distribution Width (RDW) is a measure of the variation in the size of red blood cells. An elevated RDW has been identified as an independent risk factor for mortality in CKD patients, reflecting the underlying pathophysiology of anemia associated with CKD, including iron deficiency, inflammation, and erythropoietin resistance (Tanaka et al., 2013). RDW is thought to provide additional prognostic value in CKD, particularly when combined with other markers such as hemoglobin levels and ferritin (Alvarez et al., 2019).

Urea and Creatinine are classic markers of kidney function. Elevated levels of urea and creatinine are typically indicative of impaired glomerular filtration rate (GFR), which is the hallmark of CKD (Levey et al., 2015). Urea, often used alongside creatinine, provides complementary information on renal function, with urea levels affected by factors such as protein intake, hydration, and liver function (Ninomiya et al., 2012).

Albumin is a key protein in the blood plasma that serves a variety of functions, including maintaining oncotic pressure and transporting various molecules. Hypoalbuminemia, a common finding in CKD, is associated with increased risk of complications, including cardiovascular events, infections, and mortality. The degree of albuminuria (albumin excretion in the urine) is also a key marker of CKD progression (Cattran et al., 2013). Albumin levels, in conjunction with other markers, offer critical prognostic information in CKD patients.

This study on the interplay between these biomarkers and their clinical significance in CKD is essential for improving patient care and outcomes. The following review examines the status of WBC, MPV, RDW, urea, creatinine, and albumin in CKD patients, with a focus on their diagnostic and prognostic value in the management of this chronic disease.

2. Materials and Methods

2.1 Study Site

The study was conducted at the Imo State Specialist Hospital, Umuguma, Owerri, Nigeria.

2.2 Study Design

A cross-sectional study was conducted from the month of June to September, 2023 and all eligible subjects (30 patients and 30 apparently healthy subjects) were enrolled in the study. Blood samples were collected and analyzed in the laboratory using standard operating procedures. The results of the tests were analyzed using SPSS version 21.

2.3 Method of Recruitment

The study consisted of adult chronic kidney diseased patients attending Imo specialist hospital, Umuguma, Owerri, Nigeria. A total of sixty subjects (30 patients and 30 age-matched healthy subjects) who gave their informed consent and completed the questionnaire were enrolled in the study.

2.4 Ethical Consideration

This research study was approved by the ethics and research committee of Imo specialist hospital, Umuguma, Owerri. All study participants who gave their informed consent were enrolled in this study and samples were taken.

2.5 Selection criteria

2.5.1 Inclusion criteria

Patients suffering from chronic kidney disease without any other medical conditions (in the age range of 30-65years)
Patients who gave their informed consent.
Age-matched apparently healthy subjects who served as controls.

2.5.2 Exclusion criteria

i. Patients who did not give their informed consent.
ii. Patients below and above the ages of 30-65years
iii. Patients with other medical conditions like urinary tract infections, evidence of urological disease and evidence of heart failure.

2.6 Sample Collection

Venous blood (7mls) were collected from the patients by venipuncture using sterile needles and syringes. 5 mls of blood was dispensed into plain containers and used for the estimation of serum creatinine, urea and albumin, while 2mls was dispensed EDTA containers and used for the determination of WBC, MPV and RDW. The non-haemolysed samples in the plain tubes were centrifuged and separated and the serum samples were stored at -20^{o}C prior to use, while the blood in the EDTA container was stored in the refrigerator at 4 ^{o}C.

2.8 Laboratory Analysis

The WBC, Mean Platelet Volume and Red Cell Distribution Width were estimated usingUsing haematology autoanalyser (Sysmex KX2IN). The Jaffe-Slot method was used to determine serum creatinine (test kit from Randox (Catalogue No: Cr12245370). Serum urea was estimated using Diacetyl monoxime method – urea assay kit (Catalogue Number: MAK006). The determination of serum albumin was done using the Bromocresol Green method, using Randox Albumin Assay-AL145.

3. Statistical Analysis

All data obtained in the study was analyzed using student t-test (SPSS 21) and Pearson correlation coefficent. The level of significance was set at $p < 0.05$. Values were expressed as mean±SD and results presented in tables.

4. Results

Table 1: Mean Values of Urea, Creatinine, Albumin in patients with chronic kidney disease compared to Controls.

The mean value of urea (62.77±38.59) mg/dl was significantly higher in patients suffering from chronic kidney disease when compared to controls (18.10±6.08) mg/dl (t=6.26, P=0.000).

The mean value of creatinine ((2.72±2.27)mg/dl was significantly higher in patients suffering from chronic kidney disease when compared to controls (0.66±0.31)mg/dl. (t =4.92, P=0.00), while serum albumin (3.34±0.93)mg/dl was significantly lower in subjects suffering from chronic kidney disease when compared to controls (4.50±0.86) mg/dl (t=5.01, P=0.000).

Parameter	Test	Control	t-value	p-value
Urea (mg/dl)	62.77±38.59	18.10±6.08	6.26	0.000*
Creatinine (mg/dl)	2.72±2.27	0.66±0.31	4.92	0.000*
Albumin (mg/dl)	3.34±0.93	4.50±0.86	5.01	0.000*

Table 2: Mean Values of RDW, MPV, and WBC in Patients with Chronic Kidney Disease compared to controls.

The mean values of RDW (52.12±8.42)fl and MPV (11.05±1.59)fl were significantly higher in patients suffering from chronic kidney disease when compared to controls (43.46±8.97) fL and (8.63±0.93) fl respectively.

Similarly, WBC (10.25±4.02) cells/µl was significantly raised in patients suffering from chronic kidney disease when compared to controls (5.82±2.00)cells/µl.

Parameter	Test	Control	t-value	p-value
RDW (fL)	52.12±8.42	43.46±8.97	3.85	0.000*
MPV (fl)	11.05±1.59	8.63±0.93	7.19	0.000*

WBC (cells/ µl)	10.25±4.02	5.82±2.00	5.41	0.000*

KEY:
* = Significant p value
RDW= Red Cell Distribution Width
MPV= Mean Platelet Volume
WBC= White Blood Cell

Table 3: Comparison of the Mean Values of Urea, Creatinine, Albumin, RDW, MPV and WBC in Patients with Chronic Kidney Disease based on Gender.

There was no significant difference in the mean values of urea (63.40±42.95)mg/dl, creatinine (3.09±2.85)mg/dl, albumin (3.05±0.77)mg/dl, RDW(52.11±6.78)fl, MPV (10.94±1.78)fl and WBC (10.40±4.59) cells/µl in males with chronic kidney disease when compared to the mean values of urea (62.13±35.19)mg/dl, creatinine (2.34±1.49)mg/dl, albumin (3.63±0.99)mg/dl, RDW (52.13±10.04) fl, MPV (11.17±1.44) fl and WBC (10.09±3.52) cells/µl in females with chronic kidney disease (t= 0.09, P= 0.930), (t=0.91,P=0.372), (t=1.78, P=0.086) (T=0.01,p=0.997), (t= 0.38, P=0.704) and (t= 0.21, P=0.839).

Parameter	Male 15	Female 15	t-value	p-value
Urea (mg/dl)	63.40±42.95	62.13±35.19	0.09	0.930
Creatinine (mg/dl)	3.09±2.85	2.34±1.49	0.91	0.372
Albumin (mg/dl)	3.05±0.77	3.63±0.99	1.78	0.086
RDW (fL)	52.11±6.78	52.13±10.04	0.01	0.997
MPV (fl)	10.94±1.78	11.17±1.44	0.38	0.704
WBC (cells/µl)	10.40±4.59	10.09±3.52	0.21	0.839

KEY:

RDW= Red Cell distribution width

MPV= Mean platelet Volume

WBC= White blood cell

Table 4: Comparison of the Mean Values of Urea, Creatinine, Albumin, RDW, MPV and WBC in Patients with Chronic Kidney Disease based on Age.

There were no significant difference in the mean values of Urea: 30-40 yrs (60.00±24.76), 41-50(65.13±33.87) and > 50yrs (64,33± 43.59) (f= 0.02, p= 0.981); creatinine: 30-40 yrs (2.23± 1.46), 41-50yrs (2.56±1.66) and > 50yrs (2.97±2.66) (F=0.18, p=0.840); Albumin: 30-40yrs (2.40±0.69), 41-50yrs (3.27±0.82) and >50yrs (3.45± 0.91) (f=1.87, p=0.175); RDW: 30-40yrs (48.83±2.89), 41-50(51.01±8.96) and >50yrs (53.77±8.65) (f=0.61, p= 0.550); MPV: 30-40yrs (11.20±0.79), 41-50yrs (11.34±2.27) and >50yrs (10.68±1.02) (f= 0.62, p=0.544); WBC: 30-40yrs (11.30±2.29), 41-50yrs (8.76±2.50) and >50yrs (10.92±4.59) (t=0.86, p= 0.435) respectively based on age.

Parameter	30-40 10	41-50 10	>50 10	f-value	p-value
Urea (mg/dl)	60.00±24.76	65.13±33.87	64.33±43.59	0.02	0.981
Creatinine (mg/dl)	2.23±1.46	2.56±1.66	2.97±2.66	0.18	0.840
Albumin (mg/dl)	2.40±0.69	3.27±0.82	3.45±0.91	1.87	0.175
RDW (fL)	48.83±2.89	51.01±8.96	53.77±8.65	0.61	0.550
MPV (fl)	11.20±0.79	11.34±2.27	10.68±1.02	0.62	0.544
WBC (cells/µl)	11.30±2.29	8.76±2.50	10.92±4.59	0.86	0.435

KEY:
RDW= Red Cell distribution width
MPV= Mean platelet Volume
WBC= White blood cell

Table 5: Correlation of Creatinine with Urea, Albumin, RDW, MPV and WBC in patients with chronic kidney disease.

Table 5 shows that there was a significant positive correlation of serum creatinine with urea (r= -0.64, p=0.000) and a non - significant positive correlation with albumin, RDW, MPV and WBC (r= 0.08, p=0.683; r=0.23, p=0.228; r=0.05, p=0.808 and r=0.38, p=0.039) in patients with chronic kidney disease.

Variable	N	r	p-value
Urea (mgldi)	30	0.64	0.000*
Albumin (mgldl)	30	0.08	0.683
RDW (fl)	30	0.23	0.228
MPV (fl)	30	0.05	0.808
WBC (cells/ul)	30	0.38	0.039

KEY:
*= significant p value
RDW= Red Cell distribution width
MPV= Mean platelet Volume
WBC= White blood cell

5. Discussion

Globally, chronic kidney disease (CKD), which can progress to end-stage renal disease (ESRD), has emerged as a severe health concern (Levey *et al*., 2017). It is associated with increased mortality and cardiovascular morbidity risk, resulting in a subsequent heavy social and economic burden (Coresh *et al*., 2015).

In the present study, the mean values of creatinine and urea were significantly increased in patients with chronic kidney disease when compared to controls. The increased levels of serum creatinine and urea was as a result of the inability of the kidney to remove creatinine and urea from the blood, thereby leading to an increase in serum creatinine and urea levels. Creatinine is a breakdown product of creatine phosphate in muscle, and is usually produced at a fairly constant rate by the body. Therefore, when the kidney is unable to clear the creatinine produced by the body, its level in the blood increases (Lamb *et al*., 2016). Urea on the other hand is an end product of amino acid breakdown, when the kidney is unable to clear the urea produced from the breakdown of amino acid, its level increases in the blood. This result is in line with the report by Gallagher and Seligson, (2016), in the study they stated that an impairment of renal function is commonly reflected by changes in the blood creatinine and urea.

The current study revealed that the mean value of serum albumin was significantly lower in subjects suffering from chronic kidney disease when compared to controls. Hypoalbuminemia is common in patients with chronic kidney disease (CKD). It is caused by a combination of a reduced synthesis and an increased degradation of albumin (Lang *et al*., 2013). The altered albumin homeostasis in chronic kidney disease patients is caused by a systemic inflammatory state which correlates closely with mortality. Hypoalbuminemia is a strong predictor of an adverse prognosis, but it is not a pathogenic factor in itself. The result of this study is in agreement with the study carried out by Song *et al*., (2022) who discovered that albumin was reduced in subjects with renal prognosis in 1138 patients with CKD after adjusting for confounding variables in a recent retrospective study. Another Australian study showed that serum albumin was associated with severe decline in renal outcomes in CKD patients after adjustment for adjusted for gender, urine albumin creatinine ratio.

The mean value of RDW was significantly higher in subjects suffering from chronic kidney disease when compared to controls. Elevation in the RDW is a characteristic of anaemia, which is as a result of a dysfunctional kidney. The kidney produces erythropoietin which plays an important role in red cell production therefore chronic kidney disease causes anaemia which results in increase in red cell distribution width. The result of this study agrees with the report by Erken *et al*., (2020), 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 which would result in elevated RDW.
High mean platelet volume (MPV) was found to be associated with chronic kidney disease. However, some studies have reported decreased MPV values, particularly in patients with end stage renal disease (ESRD) (Zhang *et al.*, 2017). The elevated level of MPV signifies a reflection of systemic inflammation and uremic state in patients with CKD. Study carried out by Erken *et al.*, (2020), reported that lower MPV values were associated with worse renal function, suggesting that MPV may have a role in the pathophysiology of CKD.

White blood cell (WBC) was significantly elevated in subjects with chronic kidney disease. Patients with CKD are in an inflammatory state due to increased cytokine production, oxidative stress, vitamin D deficiency, malnutrition, and susceptibility to infections. The inflammatory state of chronic kidney disease contributes to problems which results to an increase in the WBC (Shankar *et al.*, 2014). The potential mechanisms by which inflammation processes lead to the development of CKD is not yet clear. Evidence has shown that inflammation has been hypothesized to play an important role in systemic atherosclerosis development (Shankar *et al.*, 2014). Some may speculate that WBC counts are predictive of the risk of future CKD because of their relationships with many other atherosclerosis risk factors, like smoking, diabetes or hypertension (Schmidt *et al.*, 2019).

The result of the present study revealed that there was no significant relationship in the mean values of urea, creatinine, albumin, RDW, MPV and WBC in patients with CKD when compared based on sex and gender. The results clearly state that gender and sex are not a predominant factor for determining if a patient will develop chronic kidney disease or not. The result of this study concurs with the study carried out by Shankar *et al*., (2014), who reported a similar finding.

The current study revealed that there was a significant positive relationship of serum creatinine and urea levels. This agrees with the findings from previous authors, who reported a significant association between urea and creatinine as a diagnostic marker of renal disease (Libby, 2015).

There was no association of creatinine with albumin, RDW, MPV and white blood cells. The result clearly explains that the increase or decrease in creatinine level does not have any relationship with the other parameters. This result is in agreement with the study carried out by Ernandez and Mayadas, (2016).

6. Conclusion

Chronic kidney disease is associated with elevated levels of urea, creatinine, RDW, MPV, WBC and a decrease in the level of albumin. Gender and age do not affect the levels of urea, creatinine, albumin, RDW, MPV and WBC in patients with chronic kidney disease. This study demonstrated a significant association of creatinine with urea and non-significant relationship with albumin, MPV, RDW and WBC in patients with chronic kidney disease.

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