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Hematological Alterations in an Eastern Sudanese Chronic Kidney Disease Patient Population

Mohammed Omer Abaker Gibreel[1], Sundus Kamal Ibrahim[2], Wijdan Abdel Aziz Hassan[2], Manar Yahia Mahjoub[2], Leyla Mohammed Kheir Hamid[2], Hibatellah Majzoub Abbas[2], Nuha Fouzi Mohammed[2]

[1]Secretariat of Academic Affairs, Port Sudan Ahlia University, Port Sudan, Sudan
[2]Department of Hematology and Immunohematology, College of Graduate Studies, Port Sudan Ahlia University, Port Sudan, Sudan
Email: m_omer8164@yahoo.com, skmal9301@gmail.com, vedj70077@gmail.com, ymnal0952@gmail.com, laylamohamedkhair@gmail.com, kvzait@gmail.com, nohafawzy875@gmail.com

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Abstract

Background: Chronic Kidney Disease (CKD), associated with a slow and progressive loss of kidney function over a period of several years, is an important clinical disaster with an increasing rate of morbidity and mortality especially in the least developed countries. Many hematological parameters are thought to alter dramatically during the course of the disease. These include white blood cells, red blood cells, and platelets. **Methods:** We tried, retrospectively, to evaluate the peripheral blood hematological alterations in a group of patients undergoing hemodialysis in an eastern Sudan dialysis center to add local medical information. **Results:** Anemia (Low hemoglobin and hematocrit) was detected in 94% of the patients' group. Mean Erythrocyte count (3.32vs.4.76 ($\times 10^9$/L)), Hemoglobin concentration (9.4vs.13 (g/dl)), Hematocrit (28.7vs.38.7 (L/L)) and platelet count (296 vs. 238 ($\times 10^9$/L)) were significantly lower in the patients' group than in the control group (P-values < 0.050), but Mean Cell Hemoglobin Concentration (32.8 vs. 32.2 (%)) was significantly higher in the patient than in the control group (P-value < 0.050). **Conclusion:** Five out of eight studied parameters (Red cell count, hemoglobin, hematocrit, mean cell hemoglobin concentration, and platelets count) have shown a significant alteration in CKD patients. As the complete blood count (CBC) test is the most utilized test in clinical laboratory practice, these alterations may be considered as early indicators for CKD. Furthermore, all patients with CKD must be routinely checked for these alterations.

Keywords

Chronic Kidney Disease, Chronic Renal Failure, Hematological Alterations, CBC, Eastern Sudan, Hemodialysis

1. Introduction

Chronic Kidney Disease (CKD) is a global health problem, with a very high cost of care and a great burden particularly in developing countries [1]. Over 1.1 million patients are estimated to have renal failure worldwide with an annual increase of a rate of 7% [2]. CKD is a slow and progressive loss of kidney function over a period of several years. Eventually, the affected patient will develop permanent kidney failure. Many terms are used in clinical practice to describe chronic kidney disease including Chronic Renal Failure (CRF), Chronic Renal Disease (CRD) and Chronic Kidney Failure (CKF). The disease is much more widespread than people realize; it often goes undetected and undiagnosed until the disease is well advanced. The disease has been graded into five stages according to clinical severity and impairment of renal function with stage 5 being the worst and is known as End Stage Renal Disease (ESRD). The average incidence of ESRD in the Middle East countries is more than 93 per million populations [2]. CKD impacts all hematological parameters and hemodialysis also influences all these parameters [3]. Anemia is a prevalent complication of chronic renal disease, which is linked to a high rate of morbidity. As CKD progresses, changes in hematological parameters become more evident [4]. Amongst hematological parameters affected in CKD, haemoglobin concentration and RBC indices are commonly and severely affected. Hemodialysis and peritoneal dialysis are still the most common treatments for renal failure [5]. As kidney failure advances and the organ's function is severely impaired, dangerous levels of waste and fluid can rapidly build up in the body [6]. Treatment is aimed at stopping or slowing down the progression of the disease and this is usually done by controlling its underlying cause. Common symptoms of the condition include blood in urine, high blood pressure, and fatigue. Causes include diabetes, uncontrolled hypertension and specific kidney diseases such as polycystic kidney disease. There is no cure for chronic kidney disease, which means treatment is focused on reducing symptoms. Diagnosis commonly occurs after blood tests, kidney scans, or biopsy. Dialysis may be used for those with an acute disturbance in kidney function (acute renal failure) [7] or progressive but chronically worsening kidney function; a state known as chronic kidney disease stage 5 (previously chronic renal failure or end-stage renal disease). The latter form may develop over months or years, but in contrast to acute kidney injury is not usually reversible and dialysis is regarded as a "holding measure" until a kidney transplant can be performed or sometimes as the only supportive measure in those for whom a transplant would be inappro-

priate. The purpose of this research was to know the CBC hematological changes including RBCs, WBCs and platelets that occur in CKD patients as compared to healthy appearing adult controls.

2. Patients and Methods

This cross-sectional descriptive study was conducted at Port Sudan Center of Dialysis in the period from March to August 2023 to evaluate the hematological alterations in patients with chronic renal failure. The study included 100 participants; 50 patients with confirmed chronic renal failure aged between 21 and 83 years (Mean 51 years old) as the patients' group and other 50 healthy appearing adults (with no history of kidney disease and a normal renal function tests at the time of collection) aged between 24 and 80 years (Mean 51 years old) as a control group. 60% of individuals in the patients' group were males and 40% were females (**Figure 1**) while in the control 50% were males and 50% were females (**Figure 2**). All participants were subjected for testing certain hematology parameters; namely; Leucocytes count, Erythrocyte count, Hemoglobin concentration, Hematocrit, Mean Cell Volume, Mean Cell Hemoglobin, Mean Cell Hemoglobin Concentration, and Platelets Count by using the automatic hematology counter (Sysmex XP-300, Serial number C4687, Japan). Verbal consent was obtained from patients. Ethical approval was obtained from the ethics committee at Port Sudan Ahlia College, Port Sudan. Data were statistically analyzed by the Statistical product and Service Solutions (SPSS) IBM 24 program. Descriptive statistics in the form of frequencies and percentages were used to facilitate the interpretation of results and independent sample T-test for comparison between groups.

3. Results

All studied parameters were found to be within reference ranges mentioned in literature for the control group in contrast to some parameters in the test group (Hb and Hct) which were lower in the patients' group than those mentioned in the literature (**Table 1**). 94% of the participants in the patients' group were anemic. Statistically significant differences between patient and control were detected in 5 out of 8 parameters where Erythrocyte count, Hemoglobin concentration, Hematocrit and platelet count were significantly higher in the control group than in the patients' group (P-values < 0.050), but Mean Cell Hemoglobin Concentration was significantly higher in the patient than in the control group (P-value < 0.050) (**Table 1**). In patients with chronic renal failure there was no significant difference in all parameters between males and females (**Table 2**) while in the control group strongly statistically significant differences were found where Erythrocyte count and Hemoglobin concentration were significantly higher in males than in females (P-values < 0.050). Platelets count was significantly higher in females than in males in the same group (P-value 0.042) (**Table 3**).

There were no statistically significant differences between means of each leucocytes count, mean cell volume and mean cell hemoglobin when measured against the control group (P-values > 0.050) (Table 1). In the patients' group, all studied parameters were neither affected by age nor by gender while in the control group hemoglobin concentration was affected by age (P-value < 0.050) and RBCs count and hemoglobin were both affected by gender (P-values < 0.050) (Figure 3 and Figure 4).

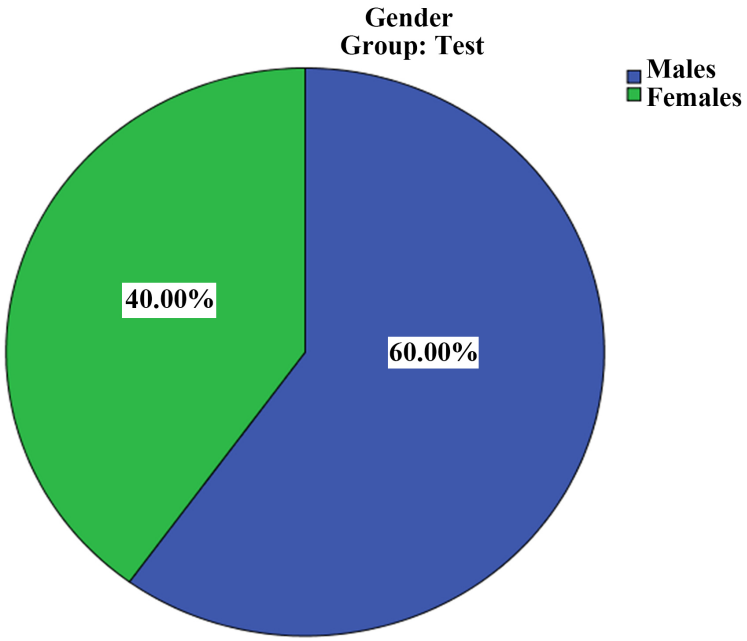

Figure 1. Frequency of Gender presentation in the test group.

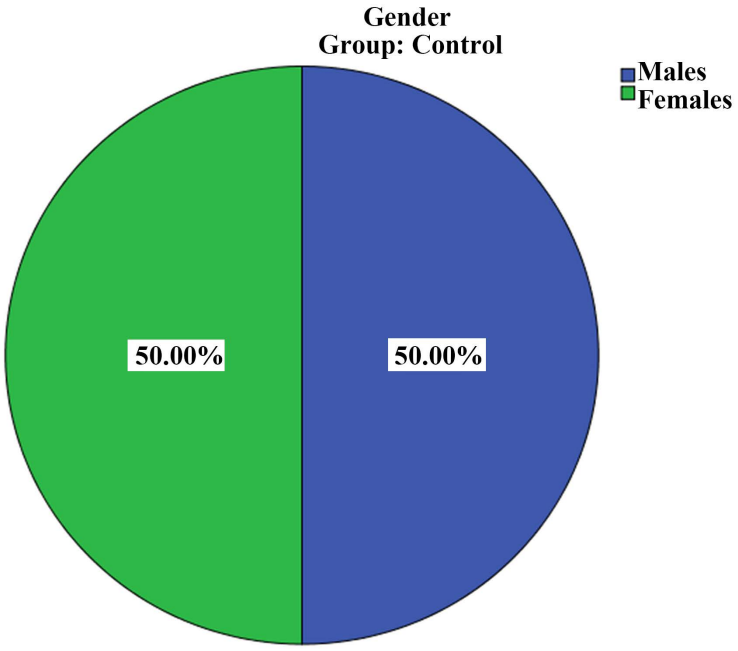

Figure 2. Frequency of Gender presentation in the control group.

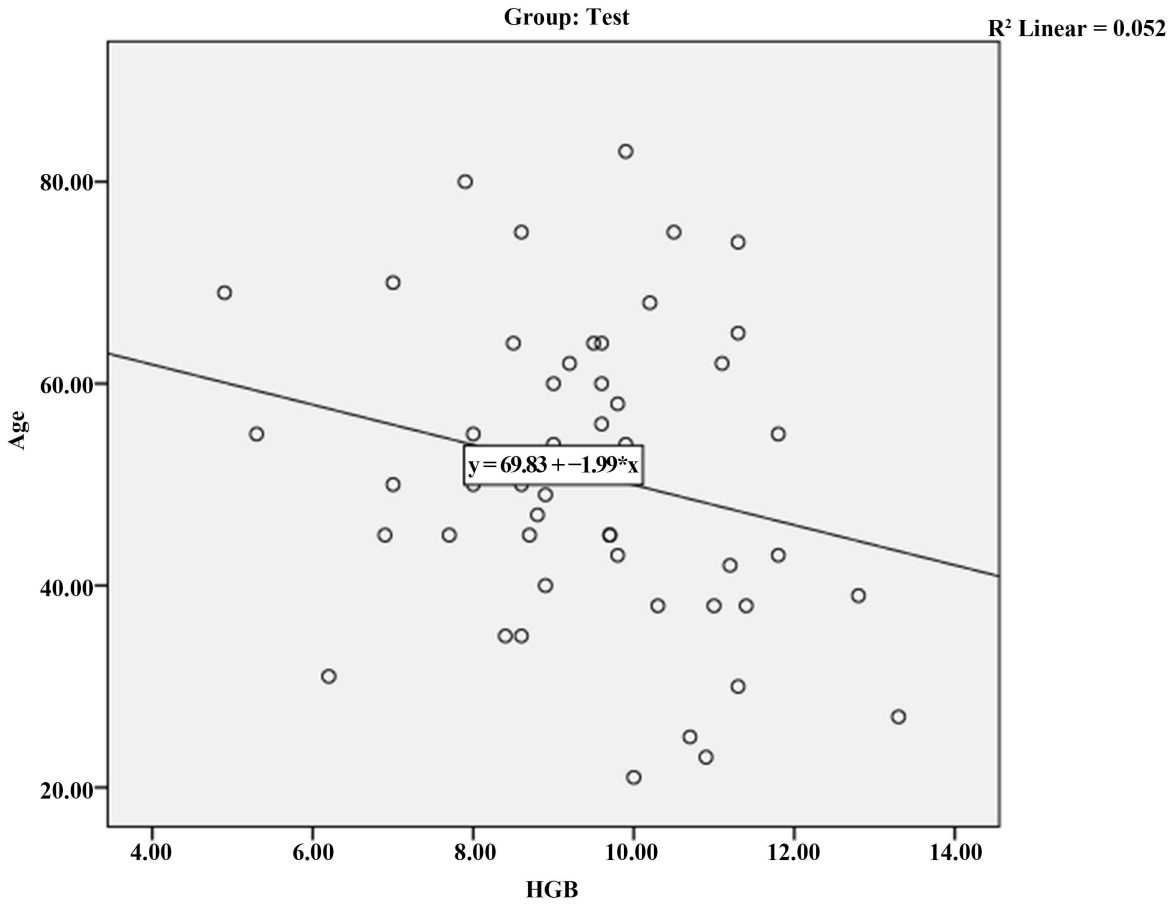

Figure 3. Correlation between age and hemoglobin concentration in the test group.

Table 1. Blood count in comparison between test and control groups.

No.	Parameter	Mean		T-test P-value
		Test Group	Control Group	
1	Leucocytes count × 10^9/L	6	6.2	0.574
2	Erythrocyte count × 10^9/L	3.32	4.76	0.000
3	Hemoglobin g/dl	9.4	13	0.000
4	Hematocrit L/L	28.7	38.7	0.000
5	Mean Cell Volume fl	85.5	83.2	0.238
6	Mean Cell Hemoglobin pg	28.4	28.6	0.921
7	Mean Cell Hemoglobin Concentration %	32.8	32.2	0.040
8	Platelet Count × 10^9/L	238	296	0.004

Table 2. Blood count in comparison between males and females in the test group.

No.	Parameter	Mean		T-test P-value
		Males	Females	
1	Leucocytes count × 10^9/L	5.8	6.3	0.504
2	Erythrocyte count × 10^9/L	3.29	3.36	0.676

Continued

3	Hemoglobin g/dl	9.3	9.6	0.549
4	Hematocrit L/L	28.4	29.1	0.670
5	Mean Cell Volume fl	85	86.4	0.583
6	Mean Cell Hemoglobin pg	28.4	28.5	0.822
7	Mean Cell Hemoglobin Concentration %	32.7	33	0.595
8	Platelet Count × 10^9/L	240	235	0.862

Table 3. Blood count in comparison between males and females in the control group.

No.	Parameter	Mean		T-test P-value
		Males	Females	
1	Leucocytes count × 10^9/L	6.3	6.2	0.965
2	Erythrocyte count × 10^9/L	4.95	4.57	0.001
3	Hemoglobin g/dl	13.7	12.2	0.000
4	Hematocrit L/L	39.6	37.8	0.432
5	Mean Cell Volume fl	85.3	81.1	0.159
6	Mean Cell Hemoglobin pg	30.5	26.6	0.164
7	Mean Cell Hemoglobin Concentration %	32.1	32.3	0.629
8	Platelet Count × 10^9/L	270	322	0.042

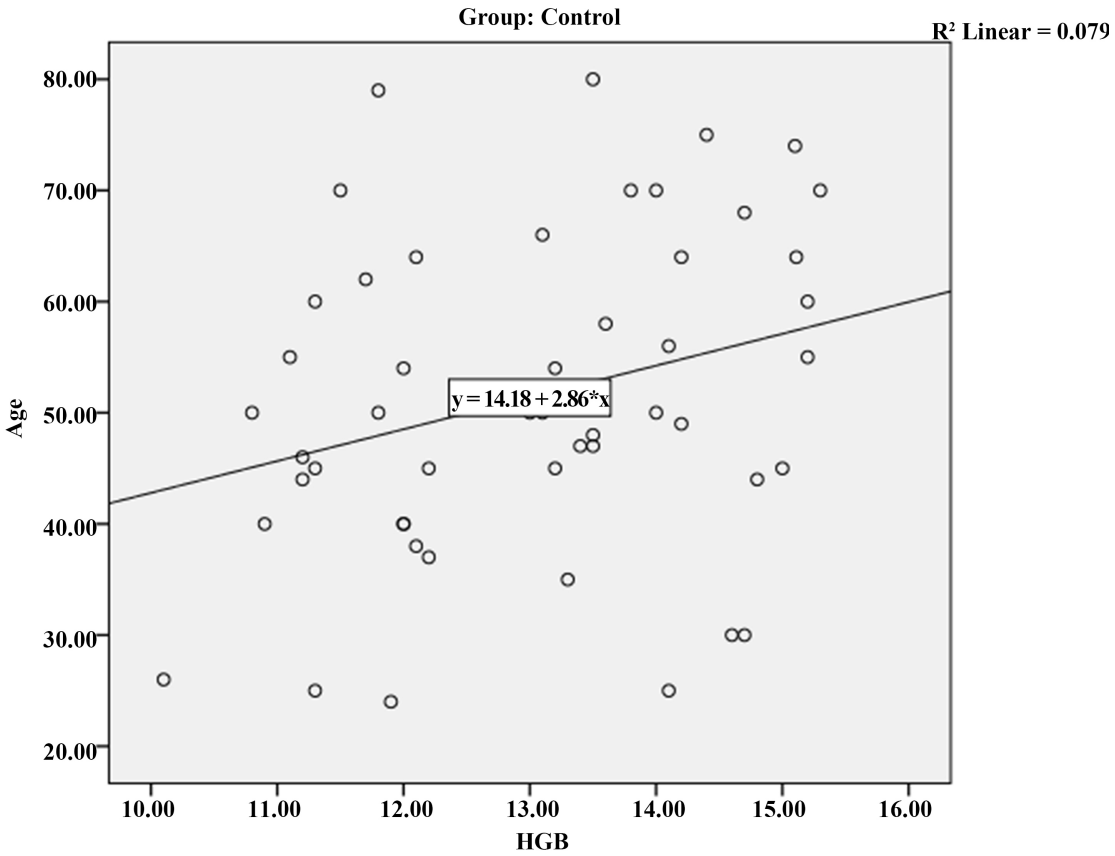

Figure 4. Correlation between age and hemoglobin concentration in the control group.

4. Discussion

Chronic Kidney Disease is associated with many hematological manifestations. These manifestations increase significantly as disease progresses and renal function decreases. In the present study, almost 94% of CKD patients included were, by definition, anemic. Anemia in CKD patients has been defined as hemoglobin (Hb) level < 13.0 g/dl in cases of males and that < 12.0 g/dl in females [8]. This is completely in concordance with the report concluding that most patients with chronic kidney disease must eventually become anemic [9]. He also added that anemia is a risk factor associated with worse prognosis. Anemia in CKD is classified as part of the anemia of chronic disease with the most common cause being erythropoietin deficiency. It was indicated that anemia is least common in stage 1 and is most common in stage 5 CKD [5]. Again these findings are agreed to our results. Due to its asymptomatic presentation and presence of other comorbidities, anemia in CKD tends to be poorly recognized on clinical settings. In a study focusing the Diagnostic performance of peripheral blood film and red blood cell indices as markers of iron deficiency among patients with chronic kidney disease in low resource settings, it was reported that iron deficiency anaemia (IDA) was a common finding among patients with chronic kidney disease (CKD) and a major contributor to the high morbidity, mortality and poor quality of life associated with the disease [10]. These findings do not differ significantly from what we have found although the study of iron profile was beyond the scope of our research. These hematological abnormalities may expose CKD patients to higher risk of anemia-related complications including reduced quality of life and an increased risk of cardiovascular mortality and morbidity [1]. The statistically significant differences observed between males and females in the control group of our study is most commonly referred to normal physiologic factors. The statistically significant reduction in peripheral blood platelet count in our patients' group as compared to the control may be attributed to the direct toxic effect of uremia on thrombocytes. In contrast, two previous studies had found no significant differences in platelets count between patients and controls [11] [12]. This may be due to the difference in sample sizes. In the present research the mean MCHC was found significantly higher in the patients' group than in the control. A finding that is completely similar to what was reported by researcher [13] and that may be attributed to the dehydration usually exhibited by CKD patients. The same findings were mentioned in a study focusing the hematological changes before and after hemodialysis in a Saudi Arabian CKD patient population which reported that there was a concurrent decrease in platelets count [2]. A slight increase in TWBCs count in CKD patients was reported in an Indonesian patient population [14]. That does not agree to our findings perhaps due to our relatively smaller sample size.

5. Conclusion

Chronic kidney disease (CKD) is a progressive disease that results in significant

morbidity and mortality. Data obtained during the present study clearly necessitates that all individuals with anemia (Distinctively with low hemoglobin and hematocrit) must be assessed for kidney function tests. And that CKD diagnosed patients should periodically be checked for the progression of anemia. This may help both in the prediction of CKD and in mitigation of anemia in these patients.

Limitations

Limitations to this study may be attributed to the smaller sample size, single clinical center used and lack of longitudinal data. Researchers have to consider that in future research.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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