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ORIGINAL ARTICLE

Assessment of Hematological changes in Chronic Kidney Failure patients undergoing Hemodialysis

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ABSTRACT

Background: Chronic kidney failure leads to a gradual loss of kidney function, necessitating interventions like hemodialysis, which significantly impacts patients' hematological profiles. Understanding these hematological changes is crucial for improving patient management and outcomes, especially in specific populations like those in Pakistan.

Objectives: To investigate the hematological changes in chronic kidney failure patients undergoing hemodialysis.

Methods: This cross-sectional study was conducted at Department of Pathology Fazaia Medical College Air University, Islamabad from 3rd May 2023 to 27th October 2023. The adult patients ≥18 years diagnosed with chronic kidney failure (CKD Stage 5) and undergoing maintenance hemodialysis for at least three months were included. Blood samples were collected from participants before the hemodialysis session, ensuring they were in a fasting state for at least 8 hours. These parameters were assessed using automated hematology analyzers and standard biochemical assays in the hospital's central laboratory.

Results: There were 55 (61.1%) males and 35 (38.9%) females in CKF patients whereas in control 54 (60%) and 36 (40%) females respectively. The mean age of CKF patients was 45.38±14.35 years, while that of controls was 44.01±12.30 years Among CKF patients, hypertension 24 (26.7%), diabetes mellitus 20 (22.2%), and the combination of diabetes mellitus with hypertension 30 (33.3%) were the predominant causes of renal failure necessitating hemodialysis. The distribution of CKF patients based on the severity of anemia revealed that a substantial proportion suffered from moderate anemia 42 (46.7%), followed by mild anemia 34 (37.8%). Few CKF patients exhibited severe anemia 6 (6.7%), while 8 (8.9%) showed normal hemoglobin levels.

Conclusion: The significant hematological abnormalities in chronic kidney failure patients undergoing hemodialysis in Pakistan, including lower levels of red blood cells, hemoglobin, and platelets compared to healthy controls

Keywords: Anemia, Chronic kidney disease, Hematological changes, Hemodialysis, Leukopenia, Thrombocytopenia

INTRODUCTION

Chronic kidney failure, also known as chronic kidney disease (CKD), represents a significant global health challenge, affecting millions of individuals worldwide.[1] Globally, it is estimated that CKD affects approximately 10-15% of the adult population.[2] This progressive condition, characterized by the gradual loss of kidney function over time, ultimately leads to the need for renal replacement therapies such as hemodialysis. Patients with CKD also suffer from a variety of complications, one of which is hematological changes as the renal function declines.[3]

ESRD patients benefit from improved quality of life and elevated haemodialysis survival rates, though they also present an array of physiological changes that impact the hematological system. The hematological disturbances in the CKD patients undergoing hemodialysis are numerous and include anemia, leukopenia, thrombocytopenia and etc. Because of the defective clotting pathways.[4] The most common hematological disorder that is distinguished by the decreased RBC count and concentrations of hemoglobin is anemia occurring in this patient group. It results from various etiologic factors like reduced Erythropoietin production by the diseased kidneys, iron deficiency, chronic inflammation and the process of HD which triggers blood loss and destruction of RBCs.[5] Anemia and leukopenia, low haemoglobin and white blood cell (WBC) count respectively are common in patients undergoing hemodialysis. There are several causes of leukopenia; one is the state of uremia and impaired bone marrow function as well as the effect of the dialysis process on WBCs, including mechanical destruction of the cells.[6]

Thrombocytopenia, a reduction in platelet count, is a significant challenge for hemodialysis patients. It can arise from various factors, including platelet destruction during dialysis, sequestration in an enlarged spleen, and impaired production due to uremic toxins.[7] Additionally, disruptions in coagulation pathways make hematological management complex for CKD patients on hemodialysis. Uremic toxins affect clotting factor function, and the chronic inflammation alters the balance between pro-coagulant and anti-coagulant forces. The use of anticoagulants during dialysis further complicates this balance, requiring careful monitoring and therapy adjustments.[8,9]

Our study aims to shed light on the hematological changes in chronic kidney failure patients undergoing hemodialysis in Pakistan, addressing a gap in the current literature.By focusing on this specific population, our research addressed critical gaps in local clinical data, offering insights into region-specific variations and challenges. Healthcare providers must be vigilant in monitoring hematological parameters, addressing underlying causes of abnormalities, and optimizing treatment strategies to mitigate the adverse effects of these changes.

METHODS

This cross-sectional study was conducted at the Pathology Department of Fazaia Medical College Air University, Islamabad from 3 May 2023 to October 2023. The study protocol was approved by the Ethical Review Committee of Hospital. Informed consent was obtained from all participants before enrollment. A sample size of 90 was calculated based on the prevalence of anemic hematological abnormalities to be 91.7% in chronic kidney failure patients undergoing hemodialysis with a confidence level of 95% and a margin of error of 5%[10] and equal number of 90 participants forming the control group. A convenience sampling method was used to recruit participants. The adult patient's age ≥18 years diagnosed with chronic kidney failure (stage 5) and undergoing maintenance hemodialysis for at least three months were included. The patients with active infections, recent blood transfusions (within the last three months), hematological malignancies, or concurrent autoimmune diseases were excluded. Data were collected using a structured questionnaire and clinical records. Blood samples were collected from participants before the hemodialysis session, ensuring they were in a fasting state for at least 8 hours. A broad range of hematological parameters was assessed, encompassing hemoglobin (Hb) levels, white blood cell

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(WBC) count, red blood cell (RBC) count, mean corpuscular volume (MCV), platelet count, mean corpuscular hemoglobin concentration (MCHC), mean corpuscular hemoglobin (MCH), serum iron, serum ferritin, reticulocyte count, transferrin saturation, and total iron-binding capacity (TIBC). These parameters were assessed using automated hematology analyzers and standard biochemical assays in the hospital's central laboratory. Data was entered and analyzed through SPSS-25.0. Comparative analysis utilized independent t-tests or Mann-Whitney U tests, with a p-value of less than 0.05 considered significant.

RESULTS

There were Gender distribution demonstrated comparable proportions between CKF patients and controls, 55 (61.1%) males and 35 (38.9%) females in CKF group while 54 (60%) males and 6 (40%) females respectively. The age of both groups showed a similar pattern, with the majority falling within the 41-60 years age range (46.7% vs 52.2%). The mean age of CKF patients was 45.38±14.35 years, while that of controls was 44.01±12.30 years [Table 1]. Among CKF patients, hypertension 24 (26.7%), diabetes mellitus 20 (22.2%), and the combination of diabetes mellitus with hypertension 30 (33.3%) were the predominant causes of renal failure necessitating hemodialysis. Other causes included drug intake 8 (8.9%), kidney stones 6 (6.7%), and chronic glomerulonephritis 2 (2.2%) [Table 2].

Table 1: Age and gender distribution of study participants

	CKD Patients		Controls	
Variable	No.	%	No.	%
Gender				
Female	35	38.9	36	40.0
Male	55	61.1	54	60.0
Age groups (years)				
21-40	32	35.6	35	38.9
41-60	42	46.7	47	52.2
> 60	16	17.8	8	8.9

Table 2: Primary causes of renal failure in CKF patients undergoing hemodialysis.

Primary cause	No.	%
Hypertension	24	26.7
Diabetes mellitus	20	22.2
Diabetes mellitus with hypertension	30	33.3
Drug intake	8	8.9
Kidney stone	6	6.7
Chronic glomerulonephritis	2	2.2

Table 3: Comparison of hematological parameters between CKF patients undergoing hemodialysis and healthy controls

	CKD Patients	Controls	p value
Hematological parameter	Mean±SD	Mean±SD	
RBC ($\times10^{12}$/L)	3.74±0.93	5.29±1.00	< 0.001[b]
Hemoglobin (g/dl)	10.8±1.28	14.4±1.34	< 0.001[b]
Hematocrit (%)	38.3±2.22	41.6±3.55	< 0.001[b]
MCV (fl)	87.5±4.20	92.7±4.30	< 0.001[a]
MCH (pg)	28.2±1.86	31.3±2.67	< 0.001[a]
MCHC (g/l)	30.6±1.08	33.3±2.39	< 0.001[b]
RDW (%)	14.8±1.31	13.1±1.41	< 0.001[a]
Platelet count ($\times10^{9}$/L)	183.8±58.5	224.6±47.3	< 0.001[a]
WBC count ($\times10^{12}$/L)	7.35±2.06	5.35±2.15	< 0.001[a]
Neutrophil ($\times10^{12}$/L)	4.72±1.33	2.37±0.95	< 0.001[b]
Lymphocyte ($\times10^{12}$/L)	1.95±0.55	1.25±0.50	< 0.001[a]
Monocyte ($\times10^{12}$/L)	0.39±0.11	0.17±0.07	< 0.001[b]
Eosinophil ($\times10^{12}$/L)	0.26±0.07	0.11±0.04	< 0.001[b]
Basophil ($\times10^{12}$/L)	0.022±0.01	0.008±0.003	< 0.001[b]

[a]Independent sample t-test; [b]Mann-Whitney U test

The CKF patients based on the severity of anemia revealed that a substantial proportion suffered from moderate anemia 42 (46.7%), followed by mild anemia 34 (37.8%). Few CKF patients exhibited severe anemia 6 (6.7%), while 8 (8.9%) showed normal hemoglobin levels as shown in Figure 1. Significant differences in various hematological parameters were observed between CKF patients undergoing hemodialysis and healthy controls [Table 3]. CKF patients exhibited lower levels of red blood cells 3.74±0.93, hemoglobin 10.8±1.28, hematocrit 38.3±2.22, mean corpuscular volume 87.5±4.20, mean corpuscular hemoglobin 28.2±1.86, mean corpuscular hemoglobin concentration 30.6±1.08, platelet count 183.8±58.5, white blood cell count 7.35±2.06, neutrophils 4.72±1.33, lymphocytes 1.95±0.55, monocytes 0.39±0.11, eosinophils 0.26±0.07 and basophils 0.022±0.01 compared to controls ($p < 0.001$). Conversely, the red cell distribution width 14.8±1.31 was higher in CKF patients than controls ($p < 0.001$).

DISCUSSION

Although hemodialysis stands as the primary therapeutic approach for chronic renal failure, its effectiveness is overshadowed by the potential for acute complications leading to significant morbidity. Given the impact of dialysis procedures on hematological parameters, vigilant monitoring of these indicators becomes imperative to mitigate complications and reduce mortality rates.[11]

In our study, the age of chronic renal failure (CKF) patients ranged from 21 to 75 years, with majority falling within the 41-60 age group (46.7%), followed by 21-40 age group (35.6%) and > 60 years age group (17.8%). This observation was comparable with the findings of Modi et al[12] who reported 47.3% patients in 41-60 years age group, 36.7% in 18-40 years age group, 16.7% in >60 years age group. The previous study of Bapat et al[13] reported that most of patients with CKF patients fell in 41-60 years age group (42.5%) followed by >60 years age group (26.8%) and 21-40 years age group (24.6%), indicating higher proportion of less than 40 and more than 60 years age group compared to the present study. The mean age for CKF patients was 45.38±14.35 years and for controls 44.01±12.30 years in our study. Shroff et al[14] also reported higher mean age for CKF patients undergoing dialysis 67.7±12.0 and controls 70.2±14.1 which contrast with our study.

This study revealed a slightly higher proportion of males in both CKF patients (61.1%) and controls (60%) compared to females (38.9% vs 40%). Ok et al[15] also reported higher proportion of males (59%) compared to females (41%) in CKF patients, which was comparable with our findings. In contrast to our findings, Ravani et al[16] higher proportion of females (56.1%) as compared to males (43.9%) in CRF patients.

In the current study, the most common cause of chronic renal failure was hypertension (26.7%) and diabetes mellitus (22.2%), followed by drug intake (8.9%), kidney stones (6.7%), and chronic glomerulonephritis (2.2%). These findings were consistent with the study of Habib et al[17] who reported hypertension in 25%, diabetes mellitus in 20%, drug intake in 10%, kidney stones 7.5% and chronic glomerulonephritis in 2.5% CKF patients. A study carried out by Rizvi et al[18] reported hypertension, diabetes mellitus and kidney stones as primary cause of CKF in 19.45%, 19.67% and 7.2% respectively, indicating lower proportion as compared to our study.

In this study of 90 CKF patients, anemia was categorized into stages: 8 patients (8.9%) had normal hemoglobin levels, while 34 patients (37.8%) had mild anemia, 42 patients (46.7%) had moderate anemia, and 6 patients (6.7%) had severe anemia. These results align with findings from Ullah et al[19] who reported mild, moderate, and severe anemia in 40%, 45%, and 4.68% of their study participants, respectively.

In this study, a significant decrease in RBCs 3.74±0.93 vs 5.29±1.00X1012/L, hemoglobin 10.8±1.28 vs 14.4±1.34 g/dl and hematocrit 38.3±2.22 vs 41.6±3.55% was associated with the CKD group compared to the control group. A study conducted by Obeagu et al[20] also reported significant decrease in red blood cell, hemoglobin and hematocrit of the chronic kidney disease patients (3.67±0.2X1012/L, 11.0±0.8 g/dl, 33.0±5.2%) compared to the control (5.11±0.4X1012/L, 15.3±0.5 g/dl, 46.0±7.2%) which was comparable with our findings.

Regarding RBC indices, the present study showed a significant reduction in MCV, MCH, MCHC in the CKF patients (87.5±4.20, 28.2±1.86, 30.6±1.08) compared to the control group

(92.7±4.30, 31.3±2.67, 33.3±2.39). Khader et al[21] also validated our results and reported significant decrease in MCV 88.29±6.03, MCH 28.29±2.18 and MCHC 33.78±1.53 compared to controls (87.09±2.89, 29.66±1.00, 34.3±1.46).

All RBC parameters decrease in this study except RDW which significantly increases in CKF patients (14.8±1.31) as compared to controls (13.1±1.41). Modi et al[12] also reported higher RDW in CKF patients (15.11±1.30) as compared to controls (13.05±1.24). The mean platelet count was 183.8±58.5 in CKF patients, which was significantly lower than the 224.6±47.3 observed in the control group. Similarly, Gafter et al[22] reported a significantly reduced mean platelet count of 1.75 ± 0.065 lakhs/mm³ in ESRD patients compared to controls. Additionally, Dorgalaleh et al[23] found that CKF patients had a mean platelet count of 1.72±0.9 lakhs/mm³, which was also lower than that of the control group.

CONCLUSION

The significant hematological abnormalities in chronic kidney failure patients undergoing hemodialysis in Pakistan, including lower levels of red blood cells, hemoglobin, and platelets compared to healthy controls. These findings underscore the importance of regular monitoring and interventions to address hematological.

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