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Hematological and Clinical Parameters in Patients of Chronic Kidney Disease (Hemodialysis dependent vs Drug dependent

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Abstract

Objective: To assess hematological and chemical parameters in association with clinical findings in patients with chronic kidney disease (CKD), comparing hemodialysis-dependent patients with those on medication.
Methodology: A prospective cross-sectional study was conducted at the Pakistan Atomic Energy Commission Hospital in collaboration with the Pakistan Institute of Medical Sciences, Islamabad, Pakistan. The study spanned six months, from April 2024 to September 2024. A total of 220 patients were included in the analysis, with 110 undergoing dialysis and 110 receiving medical treatment. Various hematological and chemical parameters were assessed using the Mindray BC-6200 hematology analyzer and Roche 6000. Clinical and laboratory findings were compared and analyzed.
Results: The mean creatinine level in the dialysis-dependent group (8.19 ± 2.68 mg/dL) was significantly higher than in the medication-dependent group (2.73 ± 0.81 mg/dL). Hemoglobin levels were lower in the dialysis-dependent group (9.8 ± 2.03 g/dL) compared to those on medication (11.7 ± 2.31 g/dL). Red cell distribution width (RDW) was elevated in the dialysis group and was associated with cardiovascular disease (CVD) and diabetes mellitus (DM). Mean platelet volume (MPV) was higher in patients on medication than in those undergoing dialysis.
Conclusion: Our study found that elevated RDW is associated with a higher incidence of CVD, DM, severe anemia, and inflammatory status (i.e., high C-reactive protein) in patients with advanced CKD. Additionally, lower MPV appears to be linked to worse kidney function.
Keywords: Chronic Kidney Disease (CKD), Mean Platelet Volume (MPV), Red Cell Distribution Width (RDW)

Introduction

Chronic kidney disease (CKD) is well-thought-out as an inflammatory illness resulting in atherosclerosis and various metabolic defects.[1] End-stage renal disease is the last stage of chronic renal failure where there is a permanent advanced worsening in renal function.[2] Anemia associated with chronic renal disease (CRD) is a type of normocytic normochromic anemia.[3] Hematological parameters such as red cell distribution width (RDW) and mean platelet volume (MPV) have been reported as indicators of chronic inflammation, cardiovascular disease (CVD), anemia, and poor renal outcomes in CKD patients.[4,5] Red cell distribution width (RDW) is a key marker of variability in red blood cell (RBC) size.[6,7,8] Recently, the RDW level was described to be inclined by the rate of red cell turnover, which allows the perseverance of older and smaller cells in circulation. Thus, delayed RBC clearance would influence RBC size variance.[6,9,10] All this shows that increased RDW is an emerging biomarker of atypical red cell metabolism and survival.6 Mean platelet volume (MPV), a readily available indicator of platelet activation and function, serves as a valuable analytical and prognostic biomarker for cardiovascular and cerebrovascular disease (CVD). MPV has been investigated occasionally in patients with chronic renal disease (CRD).[5] The increased MPV was announced as a pointer of platelet reactivity, atherosclerosis, and inflammatory status.[1,5,13] On the other hand, patients with severe swelling and some patients with advanced CRD have been described to have low MPV levels.[1,11,12] In the repetitive follow-up of patients with advanced CKD, we do not have numeric follow-up indicators. Using routine clinical markers such as RDW and MPV for this purpose could be highly beneficial. Future studies may enable the integration of RDW and MPV into the follow-up and management of CKD patients.[1] In this study, we evaluated these hematological parameters along with clinical features in patients with CKD (stage 3,4 vs stage 5). Additionally, we sought to find any indications of causal relationships between these hematological parameters, renal function, and comorbidity.

Authorship Contribution: Conception and Design, Acquisition, Analysis and Interpretation Of Data. Involved in drafting the manuscript or revising it critically for important intellectual content. Substantial contributions to the conception or design of the work, Involved in Data collection, Involved in drafting the manuscript,Final approval Involved in drafting the manuscript,

[2]final approval of the version to be published,
Funding Source: none
Conflict of Interest: none
Received: Nov 17, 2024
Accepted: Jan 13, 2024

Methodology

It was a prospective cross-sectional study conducted in the department of Nephrology and Pathology, Pakistan Atomic Energy Commission Hospital (PAEC) Islamabad in collaboration with Pathology department of Pakistan Institute of Medical Sciences (PIMS) Islamabad. This study was piloted over a period of 6 months from April 2024 to September 2024 on patients of stage 3/4/5 kidney disease. Sample size was 220, calculated by using WHO calculator. These 220 patients were divided in two groups one on dialysis and second on medicines. Their different variables specifically RDW and MPV were compared. RDW > 54 was considered as cut off for high levels and MPV< 10 for low values and found significant. Sampling technique was consecutive non- probability sampling. The blood sample for complete Blood picture was taken in Ethylenediaminetetraacetic acid (EDTA) vial and all extended red cell parameters including RDW and MPV were measured using the Mindray 6200, fully automated hematology analyzer. The sample for chemical parameters was collected in clot activator vial in all patients and analyzed by Roche-C 6000. The study closely followed the moral standards set by PAEC ethical review committee. (ERB #PGHI-IRB(DME) RCD-06-050. The data was entered and analyzed using SPSS version 20. Categorical variables were analyzed by using mean ±SD and percentages as well. P values were calculated by using independent sample t test.

Results

Total of 220 patients were analyzed. These 220 patients included 110 patients who were dialysis dependent and 110 were on drugs. In group I (Dialysis dependent) mean age group was 57.61 years and in group II (drug dependent) mean age was 55.93. Among 110 patients of dialysis 72 (65.5%) were males and rest of 38 (34.5%) were females. Out of 110 patients on medicines 58 (52.7%) were males and other 52 (47.3%) females. Results are shown in tables.

In Tables II & III P-value of certain variables were calculated after correlation between RDW and MPV and found significant if <0.05.

Table I: Demographical & Clinical features, laboratory parameters within the study population.(group I (Dialysis dependent) vs group II (Drug dependent) (n=220)

Parameters	group I (dialysis) (n = 110)mean ±SD	group II (drugs) (n=110) mean ±SD
Age (years)	57.61 ±13.92	55.93± 14.42
Gender M/F; n (%)	72(65.5%) 38 (34.5%)	58(52.7%) 52(47.3%)
Body mass index, kg/m^2	25.06 ± 5.02	27.17 ± 5.24
CKD stage3/4/5	0/ 1 / 109	36/ 69/ 5
DM; n (%)	62(56.4%)	71(64.5%)
Hypertension ;n (%)	90(81.8%)	74(67.3%)
CVD ; n (%)	41(37.3%)	39(35.5%)
SBP mmHg	147.48 ± 21.23	134.9 ± 12.23
RDW mean, %	56.66 ± 5.2	47.78 ± 6.28
High RDW n (%)	74 (67.3%)	11 (10%)
MPV mean, (%)	11.50 ±1.63	12.56 ± 2.22
Low MPV n, (%)	23(20.%)	16(14.5%)
Hemoglobin g/dL	9.8 ± 2.03	11.7 ± 2.31
Platelet count x 10^3/mm^3	198.96 ± 60.74	210.41 ± 98.75
Creatinine ;mg/dL	8.19 ± 2.68	2.73 ± 0.81
CRP ;mg/dL	33.45 ± 57.19	7.24 ±7.23
Albumin , g/dl	3.74 ± 0.35	3.89 ± 0.41
Ca x P (mg^2/dl ^{2})	40.04 ± 17.22	36.59 ± 7.26
ALT	15.78 ± 10.61	15.75 ± 10.35
Alk PO_4	270.43 ± 188.15	165.18 ± 83.95

Data presentation; mean ± SD. CKD, chronic kidney disease; CRP, C-reactive protein; CVD, cardiovascular disease; DM, diabetes mellitus; F, female; M, male; MPV, mean platelet volume; Ca, calcium; P, phosphorus; RDW, red cell distribution width; SBP, systolic blood pressure.

Discussion

Chronic Kidney Disease is defined as kidney damage or reduced renal function for a period of 3 months or more, due to any cause. Kidney damage is assessed by pathological abnormalities in kidney by imaging, biopsy or deranged Albumin to Creatinine Ratio while reduced renal function is defined as decreased estimated Glomerular Filtration Rate (eGFR).[14] Patients with CKD need renal replacement therapy as their kidney function declines to failure. Dialysis is the main option for those not eligible for transplantation, and it generally extends survival compared to conservative medical treatment.[15] We aimed to determine the hematological and clinical parameters in CKD patients along with a

Table II: Patient characteristics according to mean RDW and mean MPV values. (group I Dialysis dependent)						
Parameters	RDW <54 Mean ± SD	RDW >54 Mean ± SD	P value	MPV < 10 Mean ± SD	MPV >10 Mean ± SD	P value
Variable patients	36	74		23	87	
Age years	52.84 ±19.52	59.88± 9.53	0.22	54.7±15.11	58.38±13.58	0.998
Gender: Male Female	26(72.2%) 10 (27.8%)	46(62.2%) 28(37.8%)		12(52.2%) 11(47.8%)	60(69%) 27(31%)	
body mass index,kg/m^2	21.94 ±3.94	26.8 ± 5.12	0.03	24.96 ±5.83	25.09 ±4.83	0.057
CKD stage3/4/5 (n)	0/1/35	0/0/74		0/0/23	0/1/86	
DM; n (%)	19 (52.8%)	43(58.1)	0.001	10(43.5%)	52(59.8%)	0.230
Hypertension	31 (86.1%)	59 (79.7%)	0.17	20(87%)	70(80.5%)	0.19
CVD	6 (16.7%)	35(47.3%)	<0.001	7(30.4%)	34(39.1%)	0.04
SBP	153.03±25.32	144.78±18.52	0.11	144.7±22.26	148.22±21.02	0.837
RDW mean	51.01 ± 2.56	59.40± 3.72		57.08 ± 5.11	56.54±5.25	0.220
MPV mean	11.58±1.58	11.46±1.67	0.210	9.11±0.61	12.13±1.17	
Hemoglobin g/dL	10.60±1.89	8.39 ±1.44	0.004	9.11±0.91	12.13 ±1.17	0.27
Platelet count	189.11±54.76	203.76±63.24	0.334	182.7±56.66	203.26±61.36	0.013
creatinine, mg/dL	8.98±2.6	7.8±2.65	0.01	8.34±2.75	8.15±2.67	0.53
CRP ;mg/dL	11.53±12.52	44.11±66.76	0.001	36.16±67.46	32.73±54.58	0.218
Albumin , g/dl	3.97±0.24	3.63±0.24	<0.001	3.77±0.29	3.73±0.37	0.165
Ca x P (mg^2/dl ^{2})	42.87±17.25	38.66±17.15	0.96	42.67±19.55	39.34±16.6	0.83
ALT	14.75±8.33	16.28±11.58	0.020	17.96±12.16	15.21±10.17	0.089
Alk PO_4	292.53±159.9	259.68±200.6	0.934	261.09±155.76	272.90±196.55	0.627

Table III: Patient characteristics according to mean RDW and mean MPV values.(group II Drug dependent)						
Parameters	RDW <54 Mean ± SD	RDW >54 Mean ± SD	P value	MPV < 10 Mean ± SD	MPV >10 Mean ± SD	P value
Variable patients	99	11		16	94	
Age years	57 ±14.12	46.27± 14.1	<0.001	56.5±14.75	55.83±14.44	0.006
Gender**: Male** **Female**	53(53.5%) 476 (46.5%)	5(45.5%) 6(55.5%)		10(62.5%) 6(37.%)	48(51.1%) 46(48.9%)	
body mass index, kg/m^2	27.23±5.36	26.64 ± 4.18	<0.001	26.81 ±3.33	27.23 ±5.51	0.001
CKD stage3/4/5	25/69/5	11/0/0		9/7/0	27/62/5	
DM; n (%)	65(65.7%)	6(54.5%)	<0.001	11(68.8%)	60(63.8%)	0.010
Hypertension	68(68.7%)	6(54.5%)	0.01	11(68.8%)	63(67%)	0.17
CVD ; n (%)	33(33.3%)	6(54.5%)	0.014	4(25%)	35(37.2%)	0.13
SBP	136.04±12.34	125.54±5.22	0.159	135.63±13.65	134.87±12.05	0.27
RDW mean	46.14 ± 3.56	62.55±6.27		53.54±9.59	46.80±4.97	0.013
MPV mean,	12.6±2.16	11.21±2.48	0.013	9.28±0.45	13±1.92	
Hemoglobin g/dL	11.84±2.39	11.18±1.36	0.14	10.16±1.86	12.05±2.28	0.40
Platelet count	216±102.654.76	160.09±4.7	0.49	236.38±104.09	205.99±97.7	0.01
creatinine, mg/dL	2.66±0.8	3.31±0.68	0.091	3.03±0.81	2.67±0.80	0.19
CRP ;mg/dL	7.54±7.55	4.53±1.46	0.16	8.31±9.8	7.05±6.75	0.36
Albumin , g/dl	3.90±0.43	3.85±0.05	<0.001	4.01±0.22	3.87±0.43	0.003
Ca x P (mg^2/dl ^{2})	37.07±7.31	32.27±5.22	<0.001	34.33±5.58	36.98±7.46	0.58
ALT	16.24±10.8	11.36±1.57	0.01	15.13±8.28	15.86±10.7	0.96
Alk PO_4	163.03±86.31	184.55±57.97	0.03	183.13±105.79	162.13±79.95	0.33

comparison between dialysis dependent and drug-dependent patients in terms of RDW and MPV. We observed the patients with higher RDW in drug-dependent cases, were more anemic, had higher creatinine, lower albumin and lower platelets as compared to low RDW group. While in dialysis dependent group patients with higher RDW were older, had a lower Hb, lower albumin, higher CRP as compared to low RDW group. Moreover, the patients were more prone to have hypertension, Diabetes and CVD in higher RDW group. In another study, patients in the high RDW group were older, more likely to receive ESA therapy and iron supplements, and had a history of CVD and proteinuria compared to the low RDW group. They also had lower eGFR, hemoglobin, albumin, and ferritin levels, but higher CRP levels. They concluded that RDW escalated with advancing CKD stages ($p < 0.001$).[16] We also highlighted similar trends in our study. In another study by Lu et al, the group with increased RDW consisted of older individuals, fewer males, reduced LVEF, lower hemoglobin and albumin concentrations, and elevated

creatinine levels compared to the group with normal RDW. Additionally, RDW levels progressively rose with advancing CKD stages. A RDW value of 14.5% or higher was significantly linked to a greater occurrence of major composite cardiovascular events.[17]

Vashistha et al showed that higher RDW is strongly linked to mortality in hemodialysis patients, with better prognostic value than traditional anemia markers like hemoglobin, TSAT, and ferritin.[18] Similar findings were observed in peritoneal dialysis, NDD-CKD, and kidney transplant patients, establishing RDW as a reliable mortality risk factor across all CKD stages.[19,20] RDW has been linked to dialysis patients' all-cause mortality and NDD-CKD patients' cardiovascular risk, but its impact on kidney disease prognosis remains debated, especially in early CKD stages. Some studies associate sustained high RDW with increased risks of dialysis or kidney function decline,[6] while others found no link.[21] Current study adds evidence by showing RDW is correlated with rapid renal function loss over both short- and long-term periods. The study by Yeh HC et al. found that while RBC size variability predicts all-cause mortality in CKD patients, it does not predict progression to dialysis. This conclusion was based on a 13-year cohort analysis from a pre-ESRD registry. The mean eGFR was 27.3 mL/min/1.73m², and the mean CCI score was 5.83 ± 2.06. Patients with high RDW were older, with higher CRP and lower eGFR, hemoglobin, and albumin (P < 0.001). We also compared hematological, biochemical and clinical profile in patients with low and high MPV. In our study we found out that in both dialysis-dependent and drug-dependent groups, patients with a higher MPV had higher BMI, history of hypertension, Diabetes and CVD as compared to lower MPV group. Moreover, more patients had an advanced CKD stage in higher MPV group as compared to the low MPV group. An additional observation was that those with low MPV were more anemic and vice versa.

However, in terms of serum creatinine, although insignificant but patients with lower MPV had a higher creatinine level in serum. In another study, low MPV patients had lower eGFR; MPV was definitely associated with eGFR (P = 0.003). We did not calculate eGFR in our study. High RDW reflects comorbidity, anemia, and inflammation, while low MPV indicates poorer renal function. They concluded that a high MPV is linked to greater co-morbidity, anemia, and inflammation, while low MPV is associated with worse renal function. It highlights the significance of hematological parameters in assessing disease severity and progression in advanced CKD.[1] In another study of 1,044 patients with renal failure, higher platelet volume (≥ 10.85 fl) was associated with age (p = 0.05), hemoglobin levels, and platelet count (p < 0.001), but it was not linked to a higher prevalence or severity of coronary artery disease (CAD), in contrast to our findings.[13]

Conclusion

CKD is associated with imbalance in various chemical and hematological parameters. Chronic kidney disease (CKD) is characterized by inflammation, which exacerbates the disease's progression and causes issues like anemia and atherosclerosis.. RDW and MPV are affected by a number of these situations including stage and treatment of disease. Regular monitoring of such parameters in CKD patients is compulsory. Correction of these abnormalities help to decrease the illness and death rate related to CKD

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