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Study of the hematological parameters in chronic kidney disease patients in a tertiary care centre

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Abstract
Background: Chronic kidney disease involves variety of distinct pathophysiological mechanisms, abnormal kidney function, and a progressive decline in glomerular filtration rate (GFR). Globally, chronic kidney disease is becoming a more serious public health issue. It is a newly recognized health issue that significantly raises the morbidity and death rates from non-communicable diseases.
Methods: A cross sectional study was carried out in Laboratory of Pathology Department, B.J Medical College, Civil Hospital, and Ahmedabad over a period of 1.5 years January 2023 to July 2024. Two hundred patients of chronic kidney disease above 15 years of age, satisfying the inclusion and exclusion criteria, were included in the study.
Results: The aim of the present study is to study various changes in hematological parameters that occur in the chronic kidney disease patients.
Conclusion: The analysis of hematological parameters in patients with chronic kidney disease provides crucial insights into the disease's impact on various physiological functions. The study revealed significant deviations from normal levels across several key parameters. The study highlights the prevalence of anemia, reduced RBC count, and decreased hematocrit in chronic kidney disease patients, with a significant number showing normocytic normochromic anemia. These findings emphasize the critical role of regular and comprehensive hematological monitoring for Effective clinical management and to mitigate the progression of chronic kidney disease and improve patient outcomes.

Keywords: Chronic kidney disease, hematological parameter, anemia

Introduction
CKD is a universal public health problem. About 2 lakh people in India land into terminal renal failure annually. Renal disorders, are classified third amongst life-threatening conditions after cancer and heart disease by the National Kidney Foundation. Both the prevalence and the severity of hematological impairment rise in direct proportion to the severity of renal disease. Chronic kidney disease (CKD) defined as either kidney damage or decreased kidney functions (Decreased GFR) for 3 or more months. Chronic kidney disease is a spectrum of pathophysiologic processes associated with abnormal kidney functions and progressive decline in glomerular filtration rate (GFR) [1].
The kidneys are a pair of organ and their functions is to maintain blood homeostasis and remove waste products from the blood. Kidneys play a key role in keeping steady the electrolytes and maintaining the amount of water in the body. Another function of the kidneys is to produce hormones, such as erythropoietin and vitamin D. Renal function is monitored and assessed by the glomerular filtration rate (GFR) which is one of the most important and accurate marker [1]. The risk of worsening CKD is closely linked to both the GFR and the amount of albuminuria [2]. CKD is classified into five stages according to estimated GFR. The estimated GFR (eGFR) for CKD is <60 ml/min/1.73 m2 for >3 months as defined by US international kidney foundation's kidney disease outcomes quality initiative (K/DOQI) guideline. End stage renal disease (ESRD) is stage 5 CKD in which GFR is <15 ml/min/1.73 m2 and need renal replacement or dialysis [3]. The major risk factors for CKD include hypertension, diabetes mellitus and obesity. Hematological and biochemical parameters are affected in CKD and becomes more apparent as the disease progresses.
Various hematological parameters such as hemoglobin (Hb), hematocrit (Hct), Red Blood Cell (RBC) count, MCV, MCH, MCHC, peripheral smear morphology, total leucocyte count

(TLC) and platelets count are deranged in CKD.

These alteration are due to marrow suppression by retained uremic product and aluminium toxicity associated with hemodialysis. Anemia in CKD is frequent complication which is characterized by reduced ability of damaged kidney to produce erythropoietin (EPO), the hormone involved in proliferation and maturation of RBCs in bone marrow[4,5]. Damaged peritubular cells of kidney leads to decreased production of erythropoietin and therefore the major cause of anaemia. The other contributory factors are nutritional insufficiency due to deficiency of iron or vitamin B12, increased blood loss, shortened red cell survival by uremic toxins and drugs, mild chronic inflammation, hyperparathyroidism have also been indicated. All the factors aggravate anaemia and impair its response to therapy. Anaemias in CKD are usually normocytic normochromic, it can be microcytic hypochromic also, when associated with a superimposed iron deficiency anaemia. Some cases may have macrocytic anaemia due to Vitamin B12/folate deficiency. Uremia causes decrease in white blood cell count. Patients are also prone to bleeding because of dysfunctional platelets and also defects in platelet aggregation. Hematocrit is reduced due to hemodilution.
Anemia in CKD is associated with disease progression, cardiovascular comorbidities, cognitive impairment, sleep disorder, and higher mortality.

Aims and Objective
To analyze the variations in various RBC parameters (Hb, RBC count, hematocrit, and RBC indices) and peripheral smear findings in patients with CKD.

Materials and Methods
The present study was carried out in Laboratory of Pathology Department, B.J. Medical College, Civil Hospital, and Ahmedabad over a period of 1.5 years (January 2023 to July 2024). Materials for study consisted of personal and basic details of age, gender and hematological parameters data obtained from hospital records of patients who were known cases of chronic kidney disease admitted in medicine ward.
200 known cases of Chronic Kidney Disease (CKD) patients admitted in Medicine ward of Civil Hospital, Ahmedabad were included in study.

Inclusion criteria: All patients of CKD above 15 years of age, patients undergoing hemodialysis at least 3 months prior to the commencement of study. All patients satisfying the following criteria, were included. Criteria for diagnosis of CKD as given by – National Kidney Foundation. CKD is defined as the presence, for at least 3 months, of evidence of kidney damage with an abnormal GFR or alternatively, by a GFR <60ml/min. Kidney damage is evidenced by: proteinuria >300 mg/day or pathological abnormality found in histopathological study or renal imaging study (USG) showing bilateral contracted kidneys <9 cm with thinned parenchyma and reduced corticomedullary differentiation. Detailed history were undertaken in all patients.

Exclusion criteria: The following criteria were excluded from the study:
- Pregnant and lactating women.
- Patients aged below 15 years of age.
- History of blood transfusion during the past 3 months
- History of erythropoietin therapy during the past 3 months.

Sample collection and materials used: EDTA (Ethylene diamine tetra acetic acid) vacuette for Hematological parameters. Each anticoagulated sample was processed on a standardized, quality controlled and maintained automated cell counter – Horiba yumizen H2500. Blood films are often prepared from samples of EDTA. Blood smears are usually stained with Leishman or May-Grünwald-Giemsa stains.

Results
Demography
Hematological parameters of 200 patients, who were known cases of CKD were studied. Out of 200 patients, 109 (Percentage: 54.5%) were male and 91 (Percentage: 45.5%) were female Table I. Male to female ratio was 1.19:1, male predominance was observed. Youngest male patient was 16 years old and eldest was 75 years old. Of the 91 females, youngest was 17 years old and eldest was 71 years old.
The average age in our study was 49.31±16.04 years. Most of the patients (Percentage: 43%) were in the age group of 41-60 years. Gender wise distribution of CKD patients is described in Table II.

Table 1: Gender wise distribution of CKD patients.

Gender	No.	Percentage
Male	109	54.5%
Female	91	45.5%
Total	200	100.0%

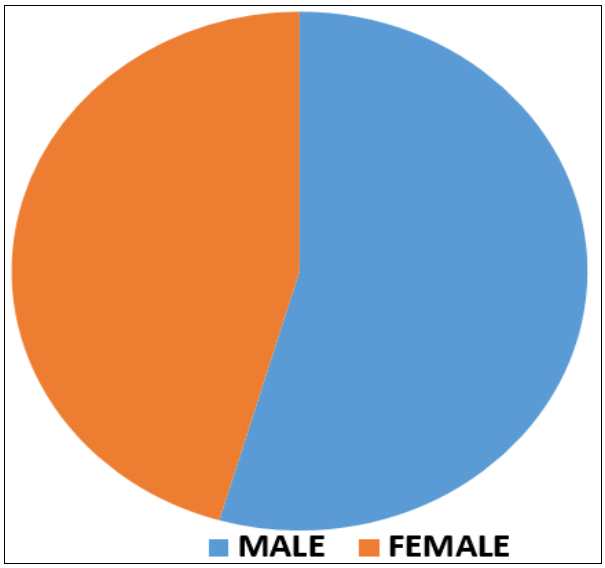

Fig 1: Gender wise distribution of CKD patients

Table 2: Age wise distribution of CKD patients

Age (Years)	No	Percentage
<20	6	3%
21-40	52	26%
41-60	86	43%
61-80	56	28%
Total	200	100%

Hematological parameters in CKD
Hemoglobin concentration

The total mean hemoglobin concentration (Hb) was 9.11g/dL and among male patients was 9.54g/dL and that among female patients was 8.61g/dL. The lowest Hb among males was 5.09 g/dL and that among females was 3.45g/dl. The highest Hb among males was 13.10 g/dL and that among females was 11.90 g/dL.

Table 3: Distribution of anemia according to gender

Anaemia	Male	%	Female	%	Total	%
No anaemia	9	4.5%	3	1.5%	12	6%
Mild anaemia	23	11.5%	17	8.5%	40	20%
Moderate Anaemia	54	27%	64	32%	118	59%
Severe Anaemia	16	8%	14	7%	30	15%
Total	102	51%	98	49%	200	100%

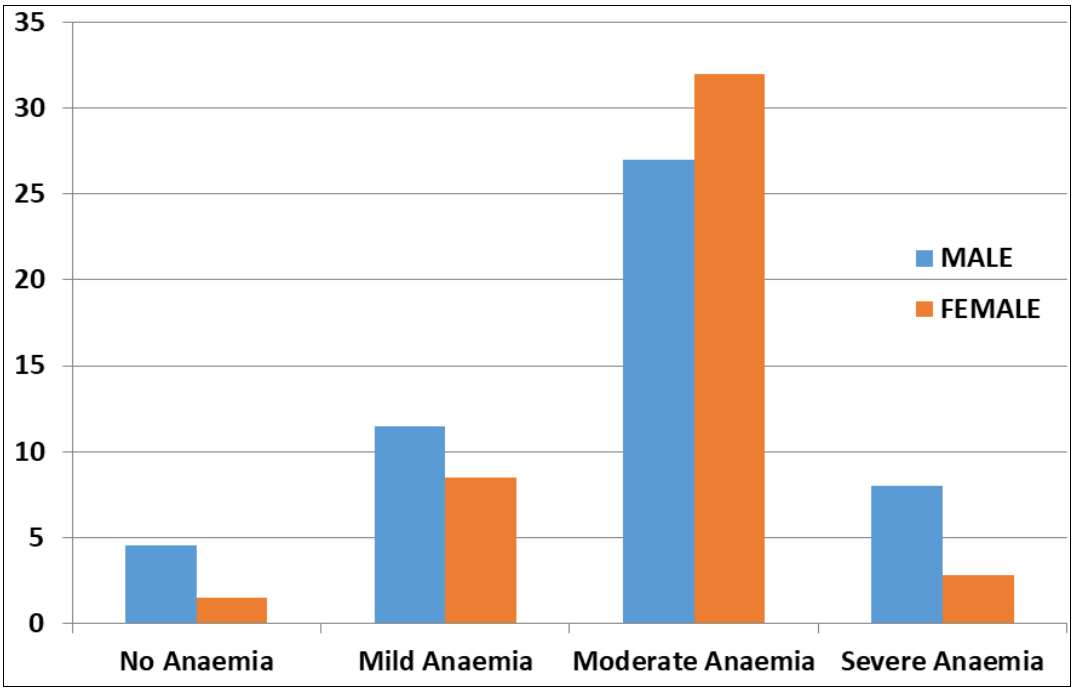

Fig 2: Distribution of anemia according to gender

Majority of the patients (N=118, Percentage: 59%) in all age groups had moderate anemia, (N=40, Percentage: 20%) had mild anemia, (N=30, Percentage: 15%) had severe anemia and (N=12, Percentage: 6%) had normal hemoglobin levels. Table III& FIGURE II: Distribution of anemia according to gender.

RBC Count

The normal RBC count for males being 4.5 million/cumm to 6.5 million/cumm and that for females being 3.8 million/cumm to 5.8 million/cumm, the total mean RBC count was 3.34±0.70 million/cumm and among male patients was 3.42±0.81 million/cumm and that among female patients was 3.22±0.66 million/cumm. The lowest RBC count among males was 1.43 million/cumm and that among females was 1.38 million/cumm. The highest RBC count among males was 5.45 million/cumm and that among females was 4.64 million/cumm. Table IV describes RBC count among male and female.

Table 4: RBC count among male and female

RBC count (million/cumm)	Male	Female
Mean	3.42±0.81	3.22±0.66
Highest	5.45	4.64
Lowest	1.43	1.38

109 males, 90 (Percentage: 45%) had reduced RBC count and of out of 91 females, 60 (Percentage: 30%) had reduced RBC count. Of 200 patients only 50 (Percentage: 25%) had normal RBC count. Distribution of RBC count according to gender is described in Table V.

Table 5: Distribution of RBC count according to gender

RBC count	Male no	%	Female no	%	Total no	%
Reduced	90	45%	60	30%	150	75%
Normal	19	9.5%	31	15.5%	50	25%
Total	109	54.5%	91	45.5%	200	100%

RBC Indices

MCV, MCH, MCHC-The normal MCV 80-100fL, MCH as 27-31 pg and MCHC as 33-37 g/dl, it was noted that majority of the patients had indices of normocytic normochromic picture. The mean for MCV was 81.68fL, MCH was 26.16pg and MCHC was 32.85g/dl**.** Distribution of RBC indices described in Table V.

Table 6: Distribution of RBC indices (MCV, MCH, and MCHC)

MCV	NO	%	MCH	NO	%	MCHC	NO	%
Reduced	75	37.5%	Reduced	85	42.5%	Reduced	95	47.5%
Normal	121	60.5%	Normal	90	45%	Normal	105	52.5%
Increased	4	2%	Increased	25	12.5%	Increased	0	0
Total	200	100%	Total	200	100%	Total	200	100%

Peripheral Smear

200 patients, 108 (Percentage: 54%) show Normocytic Normochromic picture on peripheral smear while only 28 (Percentage: 14%) patients show Microcytic Hypochromic picture on peripheral blood smear.12 (Percentage: 6%) show Macrocytic picture and 52 (Percentage: 26%) show dimorphic picture on peripheral smear.

WBC Count

The normal WBC count to be $4x10^3$/cumm to 11 $x10^3$/cumm. Among males 56 (Percentage: 28%) of 109 patients had normal WBC count, 50 (Percentage: 25%) had increased WBC count and 3 (Percentage: 1.5%) had decreased WBC count. Among females 39 (Percentage: 19.5%) of 91 patients had normal WBC count, 50 (Percentage: 25%) had increased WBC count and 2 (Percentage: 1.0%) had decreased WBC count. Distribution of WBC count according to gender is described in Table VII.

Table 7: Type of Anaemia in Peripheral smear

Type of Anaemia	Frequency	Percentage
Normocytic Normochromic	108	54%
Microcytic Hypochromic	28	14%
Macrocytic	12	6%
Dimorphic	52	26%
Total	200	100%

Table 8: Distribution of WBC count according to gender

WBC Count	Male no	%	Female no	%	Total no	%
Reduced	3	1.5%	2	1%	5	2.5%
Normal	56	28%	39	19.5%	95	47.5%
Increased	50	25%	50	25%	100	50%
Total	109	54.5%	91	45.5%	200	100%

Platelet count

Taking the normal platelet count as $150x10^3$/cumm to $450x10^3$/cumm, the total mean of platelet count was $235.37x10^3$/cumm. The lowest platelet count among males was $22x10^3$/cumm and that among females was $25x10^3$/cumm. The highest platelet count among males was $628x10^3$/cumm and that among females was $849x10^3$/cumm.

Table 9: Platelet count among male and female

Platelet count	Male	Female
Highest	628x103/cumm	849x103/cumm
Lowest	22x103/cumm	25x103/cumm

84 (Percentage: 42%) out of 109 males have normal platelet count, 21 (Percentage: 10.5%) have reduced platelet count and 4 (Percentage: 2%) have increased platelet count of the 91 females, 65 (Percentage: 32.5%) have normal platelet count, 20 (Percentage: 10.0%) have decreased and 6 (Percentage: 3%) have increased platelet count.

200 patients, 149 (Percentage: 74.5%) have normal platelet count, 41 (Percentage: 20.5%) have reduced platelet count and 10 (Percentage: 5%) have increased platelet count.

Distribution of platelet count according to gender is described in Table VIII

Table 10: Distribution of platelet count according to gender

Platelet count	Male no	%	Female no	%	Total no	%
Reduced	21	10.5%	20	10%	41	20.5%
Normal	84	42%	65	32.5%	149	74.5%
Increased	4	2%	6	3%	10	5%
Total	109	54.5%	91	45.5%	200	100%

Discussion

1. The mean hemoglobin concentration was 9.11g/dL. The majority of patients had moderate anemia (59%), followed by mild anemia (20%), severe anemia (15%), and normal levels (6%).
2. The mean RBC count was 3.34±0.70 million/cumm. The majority (75%) of patients had reduced RBC count and 25% of patients had normal RBC count.
3. The mean for MCV was 81.68fL, MCH was 26.16pg and MCHC was 32.85g/dl. Most patients had normocytic normochromic anemia, with 54% showing normocytic normochromic RBCs on peripheral smear and % showing microcytic hypochromic RBCs.
4. WBC count was observed increased in 50% of patients and normal in 47.5% patients.
5. The mean platelet count was $235.37x10^3$/cumm, with Normal platelet counts were found in 74.5% of the patients and reduced in 20.5%.

Conclusion

The study highlights the prevalence of anemia, reduced RBC count in CKD patients, with a significant number showing normocytic normochromic anemia. Additionally, there was a notable incidence of increased WBC counts and normal platelet counts among the patients. These findings underscore the importance of regular hematological monitoring in CKD management.

The analysis of hematological parameters in patients with chronic kidney disease (CKD) provides crucial insights into the disease's impact on various physiological functions. The study revealed significant deviations from normal levels across several key parameters, including hemoglobin, RBC indices, white blood cell count and platelet counts.

These abnormalities highlight the importance of regular monitoring and management of hematological parameters in CKD patients to prevent further complications and improve clinical outcomes. These findings emphasize the critical role of regular and comprehensive hematological monitoring in CKD patients for effective clinical management and to mitigate the progression of CKD and improve patient

outcomes.

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Conflict of Interest
Not available

Financial Support
Not available

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