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ORIGINAL ARTICLE

Assessment of Hematological Parameters in Chronic Renal Failure Patient: A Hospital Based Study

Devajit Nath[1], Anil Kr. Dastidar[2], Sanjeeb Kakati[3]

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ABSTRACT

Introduction: Chronic kidney disease, a leading cause of end-stage renal failure, is a growing concern globally. Diabetes and hypertension are the leading causes of this disease, with prevalence expected to double in the next 25 years, particularly in developing countries. The Kidney Disease Outcomes Quality Initiative defines chronic kidney disease as evidence of structural or functional kidney abnormalities persisting for at least 3 months, with or without a decreased glomerular filtration rate (GFR). Anemia, a closely related condition, is associated with chronic renal failure (CRF) and has public health importance in developing countries.

Objective: This study aims to determine the incidence of different types of anemia in CRF cases, changes in haematological parameters with renal failure severity, and evaluate bone marrow iron status to exclude other cases of anemia.

Results & Observation: This study analyzed the prevalence of uremic conditions in patients aged 41-60 years. The majority of cases were diabetic nephropathy, with a significant male preponderance. The majority had normocytic normochromic anemia, with a significant percentage of cases having low hemoglobin, hematocrit, red blood cell count, reticulocyte count, bone marrow iron store, and platelet count. The study found that most cases had blood urea levels between 91-120 mg/dl, with the highest level being 270 mg/dl. The study also found that uremic patients had a decline in Hb levels below 6 g/dl and high creatinine levels. The study also found that 40% of cases had Grade III scoring, with the highest percentage observed in Grade III.

AUTHOR'S AFFILIATION:

[1] Additional Professor, Department of Pathology, Postgraduate Institute of Child Health, Noida, Uttar Pradesh, India.
[2] Professor (Ex), Department of Pathology, Assam Medical College & Hospital, Dibrugarh, Assam, India.
[3] Professor, Department of Medicine, Assam Medical College & Hospital, Dibrugarh, Assam, India.

CORRESPONDING AUTHOR:

Devajit Nath, Additional Professor, Department of Pathology, Postgraduate Institute of Child Health, Noida, Uttar Pradesh, India.
E-mail: devajit_nath@yahoo.co.in

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The study analyzed the prevalence of uremic kidney disease (ESRD) in patients aged 41-60 years, with diabetes mellitus being the most common cause. Most patients had normocytic normochromic anemia (54%), followed by normocytic hypo-chromic (23.8%) and microcytic hypochromic (19.04%) anemia. Anemia was an important determinant of CRF, with blood urea levels ranging from 6.l-9gm/dl. Low platelet count (18%) was found in 9 cases, while abnormal bleeding of more than 9 minutes was found in 6 cases. Abnormal prothrombin time (20%) was found in 10 cases, and abnormal activated partial thromboplastin time (14% of cases) was found in 7 cases.

Conclusion: The present study highlights the importance of anemia and bone marrow iron status in managing patients with chronic kidney disease. The research aims to evaluate these parameters using common laboratory methods.

KEYWORDS

• Chronic Renal Failure • End Stage Renal Disease • Uremia • Diabetic nephropathy • Hematology • Anemia

INTRODUCTION

The pattern of disease morbidity and mortality throughout the world is changing both in the developed and the emerging world. During the 20th Century, infectious diseases were the major cause of death and disability. However, in this century, non–communicable, noninfectious diseases have become the major cause of mortality and morbidity around the world. The causes of chronic kidney diseases re ect this change and diabetes, together with hypertension, is now the major cause of end stage renal failure worldwide, not only within the developed world, but also increasingly within the emerging world. Diabetes is of epidemic proportions, and its prevalence will double in the next 25 years, particularly in the developing countries. This will place an enormous financial burden on countries, including the cost of the management of end–stage renal failure. Thus, it is medically and economically imperative for awareness, detection, and prevention programs to be introduced across the world, particularly in the developing countries (Atkins *et al* 2005).[1] The definition and classification of chronic renal disease may help identify affected individuals, possibly resulting in the early institution of effective therapy. To achieve this goal, the Kidney Disease Outcomes Quality Initiative (KDOQI) working group of the National Kidney Foundation of the United States dened chronic kidney disease as "evidence of structural or functional kidney abnormalities (abnormal urinalysis, imaging studies, or histology) that persist for at least 3 months, with or without a decreased glomerular filtration rate (GFR), as defined by a GFR of less than 60 mL/min per 1.73 m^2 (Sanjeev Gulati *et al* 2010)[2,3] This definition is not applicable to children younger than 2 years because they normally have a low GFR, even when corrected for body surface area. In these patient, calculated GFR based on serum creatinine can be compared with normal age–appropriate values to detect renal impairment (Sanjeev Gulati *et al* 2010).[3] The term chronic renal failure applies to the process of continuing significant irreversible reduction in nephron number, and typically corresponds to CKD stages 3–5.[4] The term end–stage renal disease represents a stage of CKD where the accumulation of toxins, fluid, and electrolytes normally excreted by the kidneys results in the uremic syndrome. This syndrome leads to death unless the toxins are removed by renal replacement therapy, using dialysis or kidney transplantation (NKF Guidelines 2000)[5] .

The close relationship between haematopoiesis and the kidney was first recognized by Richard Bright in 1835 when he described the association between anaemia and chronic renal failure.[6] Occurrence of anemia in the course of the disease process is well established. Again, it has also been reported that the severity of anemia increases along with the severity of disease Currently available data showed that CRF patient associated with anemia has a public health importance in developing countries. Extensive studies on hematological parameters related to anemia,

like hemoglobin concentration, packed cell volume and total count of red blood cell in different stages of CRF patient have shown that all these values were gradually lowered with the severity of disease.[7,8] This effect though started in mild cases but was more marked in severe CRF patient. The bone marrow cellularity is normal or slightly increased. Erythropoiesis is normoblastic with normal or increased activity but when the renal failure is advanced mild erythroid hypoplasia may occur. Myeloid and megakaryocytic series are normal or slightly increased in activity. The marrow iron content is normal or increased.[8,9]

Every year at Assam Medical College and Hospital, Dibrugarh, large number of cases with Chronic Renal Failure have been admitted for diagnosis and management where both hemodialysis and peritoneal dialysis facility is available. The result of various hematological tests commonly employed in the present study may be of enormous values in supporting the abnormality in the hematological parameter and in management of any individual case.

Aims and Objectives:

1. To find out the incidence of different type of anemia in CRF cases.
2. To study the different changes in the haematological parameter with the severity of renal failure.
3. To evaluate the bone marrow iron status to exclude other cases of anemia.

MATERIALS & METHOD

For the present prospective study, 50 cases of uremia were selected at random from different wards and from dialysis unit of Assam Medical College and Hospital for a period of 03 years.

The cases consisted of 50 cases of chronic renal failure. Blood from healthy adult persons (Doctors, attendants and technicians) were taken as controls for the tests in each case.

Inlusion Criteria:

The criteria for selection of cases of chronic renal failure were as follows (as per criteria stated by Fishberg et.al, 1939).

1. Blood urea level above 100 mg/dl
2. Insiduous onset with signs and symptoms of uraemia such as
   a. Presence of albuminuria, oliguria, pyuria, haematuria, isothenuria with or without oedema
   b. Presence of metabolic acidosis, water and electrolyte imbalance
   c. Presence of hyperkalemia, hyperphosphatemia, hypocalcemia and hyperuricemia
   d. Presence of anaemia and abnormal bleeding tendencies

Exclusion Criteria:

a. Patient with Acute Renal Failure
b. Patient with Acute Glomerulonephritis

Laboratory investigations:

Besides routine examination, the following laboratory investigations were carried out in each case included for study in the present series.

Blood:

Haemoglobin in gram percent (Hb in gm%), Total and differential leucocytic count (DLC and TLC), Platelet count, Erythrocytic sedimentation rate (E.S.R.), Reticulocyte count (%), Hematocrit (%).

Bone Marrow:

Iron Stain (Perl Stain)

Biochemical Examination:

Blood urea estimation

Serum creatinine estimation

Blood Sugar estimation

Special investigations:

1. Platelet count
2. Bleeding time
3. Coagulation time
4. Capillary fragility test of Hess
5. Prothrombin time
6. Partial thromboplastin time

Other investigations necessary for the diagnosis of the particular type of uremia were carried out as applicable to each case.

METHODS

The following techniques were employed in

the Laboratory investigations. The methods were selected from the point of view of their accuracy and simplicity.

Haemoglobin: was determined by the cyanemethemoglobin method

WBC: Was done by using improved Neubauer's chamber

RBC: Was done by using improved Neubauer's chamber

ESR: The erythrocytic sedimentation rate was done using Westergren pipette

Hematocrit: was determined by Wintrobe macrohematocrit method.

Reticulocyte count: By **Visual Method** using 1% brilliant cresyl blue stain.

Bone Marrow iron store: By **Perl iron stain.**

Blood urea or Serum urea Estimation: By Berthelot Method.

Serum Creatinine: Alkaline Picrate method.

RESULTS AND OBSERVATION

The results and observations made in this study are as follows:

The highest percentage of cases (50%) was found in the age group of 41—60 years. Also there was slight male (55.2%) preponderance in the age group of 41—60 years. In the present study, diabetic nephropathy constitute the major percentage (34%), followed by hypertensive nephropathy (28%), 20% chronic kidney disease with hypertension, 8% nephrotic syndrome, 6% connective tissue disease with nephropathy 2% congestive cardiac failure with CRF, 2% obstructive uropathy with CRF.

Overall normocytic normochromic anemia constitute the major percentage (54%), followed by normocytic hypochromic anemia (22%), dimorphic anemia (12%), microcytic hypochromic anemia (8%), macrocytic hypochromic anemia 4%. Out of total 50 cases,low hemoglobin below 6 gm/dl is observed in 30% of cases and low hematocrit below 15% was observed in 12% of cases. Low RBC count below 2 million is observed in 22 % of cases. In the total leukocyte count, count less than 5000 was observed in 16% of cases. Regarding ESR, high ESR above 90 mm was observed in 22% in cases whereas low reticulocyte count below 1% was observed in 36% of cases.

In the platelet count, 32% cases having platelet in the range of 1.5–1.9 lakhs, 22% in the range of 1–1.49 lakhs, 18% in the range of 50000–99000, 16%in the range of 2.5–3 lakh, 8% in the range of 2–2.5 lakh and 4% in the range of more than 3.5 lakhs. In the control cases 75% showed platelet count in the range of 2–2.5 lakh. The bleeding time was in the range of 1–2.59 minute in 44% of cases and in 80% of control cases. Abnormal bleeding time of 9 minutes and above was found in 6 (12%) of the uremic cases. 56% of uremic patient had clotting time in the range of 3–5.59. of the control cases 75% had clotting time in the range of 1–2.59 mints. Abnormal clotting time of more than 9 mints was observed in 4% of cases. out of total 50 cases, 80% having prothrombin time in the range of 10–14 second, followed by 20% in the range of 15–19 second. All the control cases had prothrombin time in the range of 10–14 second. Abnormal prothrombin time of above 14 second was observed in 20% of cases. out of total 50 cases, 64% having APTT in the range of 25–30 second, followed by 22% in the range of 31–35 sec, 12% in the range of 36–40 sec, and 2% in the range of 41–45 sec. 86% of the uremic patient had APTT in the range of 25–35 second. All the control cases are within that range. Abnormal APTT of more than 35 second was observed in 7 cases which accounts for 14% of total cases. Regarding blood urea level, most of the cases (34%) having blood urea level in the range of 91–120 mg/dl. The highest level was found to be 270 mg/dl. 11 patient had Hb level in the range of 3–6 g/dl for the blood urea level between 201–250 mg/dl, where as 4 patient had in the range of 201–250 mg/dl. 26 patient had Hb level in the range of 6.1–9 g/dl for blood urea level 150–200 mg/dl and 3 patient had Hb level in the range of 9.1–12 g/dl for blood urea level 251–300 mg/dl. Decline in Hb level below 6 g/dl was observed in the maximum blood urea range of 201–250 mg/dl. High creatinine above 15 mg/dl was observed in 8% of total cases. Out of total random 10 cases in which bone marrow aspiration and iron staining was done, 40% having Grade III scoring followed by 30% each in the Grade II and Grade I. The highest percentage is observed in Grade III. (Table 1-6)

Table 1: Etiology of CRF

Diabetic Nephropathy	34%
Hyper Tensive Nephropathy	28%
Nephrotic Syndrome	08%

Connectie Tissue Disease	06%
Congestive Cardiac Failure with CRF	02%
Obstructive Uropathy with CRF	02%
Glomerular Disease	20%

Table 2: Pattern of RBC morphology and anaemia in Peripheral blood smear finding

Normocytic nrmochromic	54%
Normocytic hypochromic	22%
Dimorphic anemia	12%
Microcytic hypochromic	08%
Marocytosis	04%

Table 3: Pattern of Various haematological Parameter Distribution

Parameter	Range	Percentage incidence
Hemoglobin (gm/dl)	<6gm/dl	30%
Hematocrite	15%	12%
RBC Count (Million/µl)	<2%	22%
Total Leucocyte count (/µl)	<5000	16%
ESR (mm/AEFH)	>90%	22%
Reticulocyte	<1%	36%
Bleeding Time	1-2.59	44% (Cases) 80% (Control)
	7,9	12% (Cases)
Clotting time	3-5.59 minutes	56% (Cases)
	1-2.59 7,9	75% Cases
Prothrombin time	10-14 (Second)	80% Cases
	15-19 (Second)	20% Cases
	10-14	100 (Control)
APTT	25-35 (Second)	86% (Cases) 100%(Control)
	>35	14% (Cases)

Table 4: Platelet count

Case Group		Control Group	
Range (lac/µl)	Percentage incidence	Range (lac/ µl)	Percentage incidence
0.5-0.99	18%		
1.0-1.49	22%		
1.5-1.99	32%		
2.0-2.49	08%	2.49	75%
2.5-3.0	16%		
>3.5	04%		

Table 5: Correlation between haemoglobin, blood urea level

Range HB (gm/dl)	Blood Urea (Range) (mg/dl)	No of Patient
	91-120	18
6.1-9.0	150-200	26
<6.0	201-250	
9.1-12.0	251-300	03

Table 6: Percentage distribution-Iron Staining,Bone marrow aspirate (Pearl's Stain)

Grade	Percentage	Total Cases
I	30%	3
II	30%	3
III	40%	4

DISCUSSION

In the present study, the age group varied between zero (0) to more than 60 years with maximum number (50%) in the age group of 41-60 years. Males were affected slightly more than females in the ratio of 1.4:1. The present study showed that diabetes mellitus comprises the highest percentage (34%) followed by hypertensive nephropathy (28%) and chronic kidney disease with hypertension (20%). Similar observation was made by Sakhuja *et al* from Chandigarh that in the age group over 40 years, diabetes and hypertensive nephrosclerosis exceeded or equaled CGN as the major culprit in ESRD.[10] Harrisons 'Principles of Internal Medicine' also supported the fact that the commonest etiology of CKD in western population is diabetic nephropathy (37%) followed by hypertensive (32%), urologic (6%), cystic kidney (3%) and others (7%).[11] The United States Renal Data System(USRDS) also reports that 57% of new cases of ESRD are 'attribute to hypertensive nephropathy and diabetic nephropathy. Diabetes mellitus, hypertension and CGN account for more than 80% of Medicare (US) supported ESRD cases.[12,13] The present study showed that most of the uraemic patient have normocytic normochromic anemia (54%)

followed by normocytic hypo-chromic (23.8%) and microcytic hypochromic (19.04%) anemia. This was supported by National Kidney Foundation: Kidney Disease Outcomes Quality Initiative Clinical Practice Guidelines US.[2] Moderate anisopoikilocytosis of red cells and crenated form and spherocyte was noted in the peripheral blood smear of few patient. 11 of our patient had burr cells but the majority of them were among those with blood urea above 150 mg%. This was supported by Schwartz and Motto (1949) who described burr cells for the first time.[14] Britton also stated that burr cells were found in 70 % of uremic subjects.[6]

The present study showed that most of the uraemic patient had haemoglobin levels in the range of 6.l – 9gm/dl. Of these 30% had haemoglobin below 6 gm/dl. Hence anaemia was an important determinant of CRF. This finding is consistent with the observation of Livio *et al* (1982)[15]. Roscoe observed that, on average, the blood hemoglobin decreases 2 gm per 100 ml for each increase of 50 mg% (BUN 23) in blood urea but increase in blood urea beyond 250 mg% (BUN 117) is not accompanied by any further progress of anemia; however, there is considerable individual variation in the rate of hemoglobin fall.[16] Callen and Limarzi found that in patient suffering from chronic glomerulonephritis, hemoglobin is significantly lower when BUN exceeds 100 mg and they state that some investigators have found a closer relationship between blood urea and hemoglobin concentration but the data are not convincing. Our findings are similar to those of Callen and Limarzi, because anemia was moderate when blood urea was less than 200 mg (BUN 93), more marked with blood urea more than 200 mg, with blood urea from 250 to 300 mg anemia did not progress and there was only a slight fall in hemoglobin concentration when the blood urea exceeded 301 mg[17]. Like Callen and Limarzi we did not find closer relation between blood urea and hemoglobin concentration.

In this study platelet count of less than 1 lakh was found in 9 cases (18%). The finding of low platelet count was observed by Lewis *et al* (1956) in 25% of cases.[18] Singh *et al* (1969) and Evans *et al* (1972) also reported low platelet count in 17% and 13% of uraemic patient.[14,19] Rath *et al* (1957)[16], Stewart and Castaldi (1957)[20], Huttom and O' Shea (1968) reported thrombocytopenia in 55%, 41% and 40% respectively in their study on uremic patient[21].

In the present study abnormal bleeding of more than 9 mints were found in 6 cases of uraemia, all of which had evidence of clinical bleeding. This amounted for 12% of the cases. This finding was consistent with the findings of Lewis *et al* (1956)[18] who found abnormal bleeding time in 16.6% of their cases and Cheney and Bonnin in 1962 who found the incidence to be 12% in their cases. Whereas abnormal C.T of more than 9 mints was observed in 4% of cases.[22]

Abnormal prothrombin time was seen in 10 cases (20%). This finding was consistent with the findings of Dube *et al* (1973)[7] whose study revealed abnormal prothrombin time in 42.9% of cases. Rabiner S.F 1972 reported abnormal prothrombin time 1/4th-1/2 of uraemic patient.[23]

In the present study abnormal activated partial thromboplastin time was seen in 7 cases that amounted to 14% of the total cases. This finding is similar to a study made by Dube *ét al* in 1973 who found normal activated partial thromboplastin time in 14.3% of cases.[7]

In this study the Hess's tourniquet test was done in all the 50 cases but none showed positive results. In a similar study Lewis *et al* (1956) also did not find any evidence of increased capillary fragility in patient with uraemia inspite of the patient having haemorrhagic manifestations.[18]

In the present study, bone marrow aspiration and Iron staining was done in 10 cases in which serum ferritin level was more than 300 ng, 40% had Iron scoring of Grade III. 80% of male patient having Grade II and Grade III. Among 5 female patient 30% having Iron score of Grade III.

CONCLUSION

Chronic Renal failure adversely affects a number of hematological parameters. Red cell production and destruction, granulocyte and lymphocyte function, platelet function and coagulation are affected to various degrees. These changes result in anemia, and an increased susceptibility to infection and hemorrhage.

A simple approach has been made in this research work using common laboratory methods to evaluate the parameters affecting hematological and coagulation pathway in

chronic renal failure patient with special emphasis on anemia and bone marrow iron status and to highlight its importance in management of patient with chronic kidney disease.

Conflict of Interest: The Authors Declare No Conflict of Interest

Funding: Nil

Ethics Declaration: Ethical Waiver Was Sought as the Investigation was Part of the Routine Practice and Poses Minimal Risk to the Patient. We Acknowledge the Importance of Ethical Considerations and have Taken Steps to Ensure The Privacy and Confidentiality of Participants.

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