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PREVALENCE OF ANAEMIA AMONG PATIENTS OF CHRONIC KIDNEY DISEASE ON MAINTENANCE HEMODIALYSIS WITH AND WITHOUT TYPE 2 DIABETES MELLITUS: A COMPARATIVE STUDY

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Abstract

Background: Anaemia is a frequent complication of chronic kidney disease (CKD), particularly in patients undergoing maintenance hemodialysis. The coexistence of type 2 diabetes mellitus (T2DM) may exacerbate anaemia severity and alter its patterns.

Objectives: To determine the prevalence and types of anaemia among CKD patients on maintenance hemodialysis with and without T2DM, and to compare blood parameters between the two groups.

Methods: A cross-sectional analytical study was conducted among patients with CKD undergoing maintenance hemodialysis. Participants were stratified based on T2DM status. Socio-demographic details, ultrasonographic (USG) findings, haematological indices, and biochemical parameters were recorded and compared using appropriate statistical tests.

Results: Diabetes prevalence increased significantly with age ($p<0.05$). Anaemia was significantly more prevalent in CKD patients with T2DM (47.7%) than without T2DM (33.0%). Normocytic normochromic anaemia (25.0%) was the most common subtype in the T2DM group, while microcytic hypochromic anaemia was more common in non-diabetic patients. Serum creatinine, HbA1c, and fasting blood sugar were significantly higher in the T2DM group ($p<0.05$). Gender distribution did not significantly affect anaemia prevalence or type.

Conclusion: Anaemia is more prevalent and severe among CKD patients on maintenance hemodialysis with T2DM. Early recognition and targeted management are essential to improve outcomes in this high-risk population.

Key Words: Anaemia; Diabetes; Macrocytic Hypochromic; Microcytic Hypochromic.

Introduction

Chronic kidney disease (CKD) is a global health burden associated with significant morbidity and mortality. [1] An estimated 700–850 million people worldwide suffer from CKD, with low- and middle-income countries (LMICs) accounting for the bulk of cases.[2] Anaemia is one of its most common complications, resulting from reduced erythropoietin production, iron deficiency, and chronic inflammation. [3,4] Patients on maintenance haemodialysis (MHD) are particularly

vulnerable, as dialysis can exacerbate blood loss and iron depletion.
The coexistence of type 2 diabetes mellitus (T2DM), a leading cause of CKD worldwide, further compounds the risk of anaemia. T2DM is associated with impaired erythropoietin response, autonomic dysfunction, and microvascular complications that aggravate anaemia It was found that anaemia in diabetic CKD patients develops earlier, is more severe, and has a distinct morphological pattern compared with non-diabetic CKD patients. [5,6]
The people with chronic kidney disease (CKD), especially those receiving maintenance hemodialysis (MHD) and also having concurrent Type 2 Diabetes Mellitus (T2DM), this research is critical to improve clinical practice and patient outcomes. Because the underlying illnesses in these communities have a distinct impact on the prevalence, type, and management of anemia, it is imperative to comprehend the specific patterns of anemia in these populations.
This study aims to determine the prevalence and types of anaemia in CKD patients on maintenance haemodialysis (MHD) with T2DM and without T2DM and to compare associated hematological and biochemical parameters.

Materials and Methods Study Design and Population:

A hospital-based cross-sectional analytical study was conducted among CKD patients undergoing MHD. Participants were divided into two groups: those with T2DM and those without.

Study Area: Present study was conducted in the Department of General Medicine, G.R. Medical College, Gwalior (M.P.) India.

Sample Size: Assuming the prevalence of anaemia among the diabetic patient was 47.8% (P_1) and among the non-diabetic patients was 27.4 % (P_2) at 5% level of significance and 80% power of test.

$$n = \frac{[Z_{\alpha/2}\sqrt{2PQ} + Z_{1-\beta}\sqrt{P_1Q_1+P_2Q_2}\,]^2}{(P_1-P_2)^2}$$

Calculated sample size was 88 in each group. So, using the formula our sample size was 176.

Inclusion Criteria: Patients of Anaemia in CKD on MHD patients with or without DM type 2 and having age $\geq$ 18 years were included in this study.

Exclusion Criteria: Patients Age < 18 years, who did not give consent, Diabetes mellitus type I, Patient having kidney transplant, Patients with haematological malignancies, acute infections, or blood transfusion within 2 weeks were excluded from the study.

Methods: The results of the blood test were immediately informed to the study participants and appropriate management based on the results was carried out by the attending physician. Patients' involvement was only during their clinic visit when they completed the self- administered questionnaire. Anaemia was defined based on KDIGO clinical practice guideline for anaemia in CKD when Hb<13.0 g/ dL in men and <12.0 g/dL in women.
Data were collected on age, sex, clinical history, and ultrasonography (USG) findings of the kidneys. Laboratory investigations included haemoglobin, mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), serum creatinine, fasting blood sugar (FBS), and glycated haemoglobin (HbA1c). Anaemia typing was performed as per peripheral smear and red cell indices.

Statistical Analysis: All the data was entered in a data collection sheet in an Excel format and analysed using Jamovi Statistical Software. Numerical values were reported using mean and standard deviation or median. Categorical values were reported using number and percentages.
Chi Square test and independent t test was applied. Probability value (p) value less than 0.05 was considered a statistically significant.

Results: In this study; in the age group ≤40 Years the diabetes was present among the 5.1%, in the age group 41-50 years the diabetes was present among the 48.9%, in the age group 51- 60 years the diabetes was present among the 71.7%, in the age group 61-70 years the diabetes was present among the 68.0%, in the age group >70 years the diabetes was present among the 64.3%

participants. This difference for the diabetes in the different age group was statistically significant (p value<0.05). The mean age among the non-diabetes group was 44.87±14.86 and the mean age among the diabetes group was 57.24±9.53 years. The risk of the diabetes increases as the age increases. The diabetes was present among the 50.0% females and 50% males. There was no significant difference in the distribution of the diabetes according to the gender (p value>0.05).

Table 1: Association of the USG Findings with the Diabetes

Variables		**MHD without T2DM**		**MHD with T2DM**		**Chi Square test**	**P value**
		n	**%**	**n**	**%**		
USG whole abdomen findings	**B/L contracted kidney (n=33)**	22	66.7%	11	33.3%	4.513	0.034
	B/L renal echotexture raised and CMD blurred (n=143)	66	46.2%	77	53.8%		
Anaemic	**Non-Anaemic (n=105)**	59	67.0%	46	52.3%	3.990	0.046
	Anaemic (n=71)	29	33.0%	42	47.7%		

The diabetes was present among the 33.3% patients who shown the USG abdomen finding B/L contracted kidney while the diabetes was present among the 53.8% patients who shown the USG abdomen finding B/L renal echotexture raised and CMD blurred. Diabetes was significantly higher in the group B/L renal echotexture raised and CMD blurred as compared with the patients of finding B/L contracted kidney (p value<0.05). The prevalence of Anaemia was **47.7%** among the patients of CKD on maintenance hemodialysis with DM type 2 and the prevalence of Anaemia was **33.0 %** among the patients of CKD on maintenance hemodialysis without DM type 2. The prevalence of anemia was significantly higher among the patients of CKD on maintenance hemodialysis with DM type 2 as compared with the without DM type2. [Table 1]

Table 2: The prevalence of anaemia typing among patients of CKD on maintenance hemodialysis with DM type 2 and without DM type 2

Variables		MHD without		MHD with		**Chi Square test**	**P value**
		n	**%**	**n**	**%**		
Anaemia typing	**Non-Anaemic (n=105)**	59	67.0%	46	52.3%	4.530	0.210
	Macrocytic Hypochromic (N=3)	1	1.1%	2	2.3%		
	Microcytic Hypochromic (N=33)	15	17.0%	18	20.5%		
	Normocytic Normochromic (N=35)	13	14.8%	22	25.0%		

The prevalence of macrocytic hypochromic Anaemia was 2.3 % among the patients of CKD on MHD with T2DM and it was 1.1 % among MHD without T2DM. The prevalence of microcytic hypochromic Anaemia was 20.5 % among MHD with T2DM. The prevalence of normocytic normochromic Anaemia was 25.0 % among MHD with T2DM and it was 14.8 % among MHD with T2DM. The distribution of the anaemia typing according to the diabetes was not significant. [Table 2]

Table 3: Comparison of Blood parameters between the patients of CKD on maintenance hemodialysis with DM type 2 and without DM type 2

Blood parameters	**MHD without T2DM**		**MHD with T2DM**		**T value**	**P value**
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**		
Serum creatine	5.38	0.79	5.62	0.67	-2.160	0.032
Haemoglobin	12.55	1.96	11.99	2.22	1.764	0.079
MCV	80.23	6.62	80.36	8.33	-0.117	0.907
MCH	26.45	2.52	26.21	2.25	0.654	0.514

MCHC	32.25	3.26	32.55	3.65	-0.577	0.565
HbA1C	4.66	0.50	9.49	3.09	-14.479	0.000
FBS	79.23	9.09	160.49	20.26	-34.332	0.000

Mean serum creatinine was 5.62±0.67 among the diabetes patients and 5.38±0.79 among the non-diabetes patients. Mean Haemoglobin was 11.99±2.22 among the diabetes patients and 12.55±1.96 among the non-diabetes patients. Mean MCV was 80.36±8.33 among the diabetes patients and 80.23±6.62 among the non-diabetes patients. Mean MCH was 26.21±2.25 among the diabetes patients and 26.45±2.52 among the non-diabetes patients. Mean MCHC was 32.55±3.65 among the diabetes patients and 32.25±3.26 among the non-diabetes patients. Mean HbA1C was 9.49±3.09 among the diabetes patients and 4.66±0.50 among the non- diabetes patients. Mean FBS was 160.49±20.26 among the diabetes patients and 79.23±9.09 among the non-diabetes patients. Serum creatine, HbA1C and FBS was significantly higher among the diabetes patients as compared with the non-diabetes patients (p value < 0.05). [Table 3]

Table 4: Gender wise distribution of the Anaemia Typing according to the Diabetes status

Diabetes	**Sex**	**Anaemia typing**							
		Non - Anaemic		**Macrocytic Hypochromic**		**Microcytic Hypochromic**		**Normocytic Normochromic**	
		n	%	n	%	n	%	n	%
MHD without T2DM	**Female**	20	64.5%	1	3.2%	4	12.9%	6	19.4%
	Male	39	68.4%	0	0.0%	11	19.3%	7	12.3%
MHD with T2DM	**Female**	18	58.1%	0	0.0%	8	25.8%	5	16.1%
	Male	28	49.1%	2	3.5%	10	17.5%	17	29.8%

For the Non-Diabetes participants; among the females the Macrocytic Hypochromic, Microcytic Hypochromic and Normocytic Normochromic Anaemia was present among the 3.2%, 12.9%, and 19.4% respectively. Among the males the Macrocytic Hypochromic, Microcytic Hypochromic and Normocytic Normochromic Anaemia was present among the 0.0%, 19.3%, and 12.3% respectively**.** **For the participants having the Diabetes**; Among the females the Macrocytic Hypochromic, Microcytic Hypochromic and Normocytic Normochromic Anaemia was present among the 0.0%, 25.8%, and 16.1% respectively. Among the males the Macrocytic Hypochromic, Microcytic Hypochromic and Normocytic Normochromic Anaemia was present among the 3.5%, 17.5%, and 29.8% respectively. [Table 4]

Discussion

In the present study strong association was observed between increasing age and the prevalence of diabetes, with the highest diabetes prevalence (71.7%) recorded in the 51–60 years age group. The mean age of diabetic patients was significantly higher (57.24±9.53 years) compared to their non-diabetic counterparts (44.87±14.86 years), supporting the age-related diabetes risk gradient among the study population. This finding is consistent with global trends where type 2 diabetes incidence escalates with age due to a combination of declining pancreatic function and increased insulin resistance. The Type 2 diabetes was most commonly diagnosed in middle-aged and older adults, it's increasingly being diagnosed in younger individuals, including children and adolescents which was observed by Nguyen QM et al. [7] the age at which diabetes is diagnosed can influence the long-

term health outcomes. For example, study conducted by El-Metwally A et al found that diabetes diagnosed at 46-60 years and >60 years was associated with a higher risk of diabetes [8]. Vega T et al observed that the greatest incidence of T2DM was found in 55-64-year-old men and 65-69-year-old women [9]. No significant gender-based difference was observed in diabetes prevalence, aligning with prior literature suggesting that both sexes are equally vulnerable to diabetes in the context of CKD. El-Metwally A et al (2023) also observed that 53.7% males and 46.3% females were had diabetes [8].

Ultrasound Findings and Their Association with Diabetes: A noteworthy association was found between the type of kidney damage seen on USG abdomen and the presence of diabetes. Patients with B/L renal echotexture raised and CMD blurred were significantly more likely to have diabetes than those with B/L contracted kidneys. This may reflect the pathophysiological progression of diabetic nephropathy, which typically presents with preserved kidney size but altered echotexture in early stages, contrasting with the shrunken kidneys seen in other CKD etiologies.

Anaemia Prevalence and Its Association with Diabetes: Anaemia was prevalent in 47.7% of diabetic CKD patients on haemodialysis, significantly higher than the 33.0% in non-diabetic patients. This supports the hypothesis that diabetic nephropathy contributes more substantially to anaemia due to more profound impairment in erythropoietin production, chronic inflammation, and poor glycaemic control. The difference in haemoglobin levels (11.99±2.22 in diabetics vs. 12.55±1.96 in non-diabetics) reinforces the increased anaemia burden in diabetic individuals. It may suggest the need for more targeted interventions and monitoring for these patients to prevent or manage anaemia effectively. Zaawari A et al found that the prevalence of anaemia was 82.4% among study participants [10]. The routine screening and evaluation for CKD patients plays a major role in preventing complications of CKD, including anaemia. As reported in the literature of the studies of Adera H et al, Ammirati AL et al, Alharbi R et al, McClellan W et al, hypertension and diabetes mellitus have been among the top predictive factors for the development of anemia [11-14]. Our study result is also higher than the 43.18% reported in a study conducted in South Africa by Nalado et al. [15]. Brière M et al
[16] observed that anaemia was observed in 1065 (25.7%) of the diabetes individual. This number is lower than the finding of present study. The studies performed in Harari region, Eastern Ethiopia (34.8%), and northeast of the country (20.1%) also reported lower proportion of anemia as compared with the present study among the diabetic patients [17,18]. Similar to our study Kalagara et al also observe that anaemia was more prevalent among diabetic individuals than the non-diabetic population [19]. Chronic high blood sugar levels in diabetes can damage blood vessels throughout the body, including those in the kidneys. This damage, known as diabetic nephropathy, can lead to a decline in kidney function and reduced erythropoietin production. Erythropoietin is crucial for stimulating the bone marrow to produce red blood cells, so its deficiency can result in anaemia. Diabetes can also increase the risk of iron deficiency, which is a common cause of anaemia. This can be due to factors like poor absorption of iron, increased iron loss, or increased iron needs in certain diabetic individuals.

Biochemical and Hematologic Markers: Serum creatinine, HbA1c, and fasting blood sugar (FBS) were significantly higher in diabetic patients, as expected. Anaemic patients also had significantly higher serum creatinine, HbA1c, and FBS, indicating a correlation between poor glycaemic control and anaemia severity. Haematological indices such as haemoglobin, MCV, MCH, and MCHC were significantly lower in anaemic patients, providing objective evidence of impaired red cell production and morphology.

Kim et al. [20] also demonstrated that among diabetic patients with pre-dialysis CKD, glucose/HbA1c and glycated albumin/HbA1c ratios correlated inversely with eGFR, whereas the glucose/glycated albumin ratio did not. Considering the effect of Hb, Agarwal et al. [21] reported that among 128 patients with DM and CKD, a decline in HbA1c correlated with advancing CKD stages, but the statistical significance was removed after adjustment for Hb.

Conclusion

This study highlights a strong and statistically significant association between increasing age and the prevalence of both diabetes mellitus (DM) and anaemia among patients with chronic kidney disease (CKD) on maintenance haemodialysis. The prevalence of diabetes rose markedly with age, peaking in the 51–60 age group, while anaemia was most common among participants over 70 years. Although the prevalence of diabetes was similar across genders, age was a significant risk factor. Furthermore, specific ultrasonographic findings were associated with higher rates of both diabetes and anaemia, indicating a correlation between renal structural abnormalities and these comorbidities. Anaemia is significantly more prevalent in CKD patients on MHD with T2DM compared to non-diabetic counterparts. Normocytic normochromic anaemia is the most frequent type in diabetic CKD, whereas microcytic hypochromic anaemia is more common in non-diabetic CKD. These findings highlight the need for targeted anaemia screening and management in diabetic CKD patients.

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