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RESEARCH ARTICLE

Study of anemia in diabetic and non-diabetic subjects: A hospital-based study in Lucknow, Uttar Pradesh

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ABSTRACT

Background: India is expected to be the Diabetic Capital of World in the coming years. Alarmingly by 2045, it is expected that 130 million Indians will be having diabetes. It alters the physiology of the human body and the associated renal insufficiency, inflammation, and oxidative stress further complicate the disease. Anemia is expected to be present in 11–65% of diabetics. Anemia in diabetics thus requires investigation and cannot be neglected. **Aims and Objectives:** The present study was undertaken to study the anemia in diabetic and non-diabetic subjects. **Materials and Methods:** The present study included 92 subjects divided into diabetic (n = 48) and non-diabetic (n = 44) groups. Hemoglobin (Hb) and blood indices (mean corpuscular volume [MCV], mean corpuscular Hb [MCH], and MCHC concentration [MCHC]) were compared and further evaluation was done on the basis of the severity of anemia (as per the WHO classification). Statistical unpaired t-test was employed for data analysis. $P < 0.05$ was taken as statistically significant. **Results:** Among the diabetic group out of 48 subjects, mild, moderate, and severe anemia was present in 8 (Hb in g/dl was 11.25 ± 0.26), 11 (9.73 ± 0.83 g/dl Hb), and 4 (6.13 ± 1.15 g/dl Hb) subjects, respectively. In non-diabetic subjects, mild and moderate anemia was present in 5 (11.42 ± 0.33 g/dl Hb) and 7 (9.98 ± 0.83 g/dl Hb) subjects, respectively. Thus, in diabetics, the percentage of those having moderate anemia was more as compared to non-diabetics. In diabetics out of 48 subjects, 27 were female (56.25%) and 21 (43.75%) were male. Similarly, in non-diabetics, 28 (63.64%) were female and 16 (36.36%) were male. In the present study, the mean ± SD age (years) of diabetics and non-diabetics was found to be 44.17 ± 8.82 and 41.6 ± 8.80, respectively. The difference in mean ± SD values of Hb was found to be insignificant with P = 0.167. Similarly, insignificant differences were found between the mean ± SD values of blood indices, namely, MCV (P = 1.795), MCH (P = 0.897), and MCHC (P = 1.484), respectively, between diabetics and non-diabetics. **Conclusions:** On the basis of the study, it may be concluded that female gender and the elderly are prone to anemia and thus are expected to be more prone to complications due to anemia in diabetes. The duration of diabetes is expected to influence the results and thus requires inclusion in the study design.

KEY WORDS: Hospital Based; Anemia; Diabetes; Renal Insufficiency; Inflammation; Gender; Hemoglobin; Blood Indices

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INTRODUCTION

Diabetes caused mainly due to insulin deficiency and also as a part of metabolic syndrome is becoming prevalent in India. It is a disease of both developed and developing countries. It is estimated that by 2030, more than 350 million people will be suffering from diabetes worldwide and approximately

80 million will be from India alone which is expected to rise to 130 million by 2045.[1,2] Diabetes like other metabolic disorders is associated with multiple complications and comorbidities. Anemia characterized by deficiency of red blood cell (RBC) and hemoglobin (Hb) and decrease in oxygen-carrying capacity is prevalent in diabetics. Reportedly, the prevalence of anemia in diabetes ranges from 11% to 65%.[3,4] Diabetics are prone to multiple disorders with advancement in disease. Renal insufficiency resulting in erythropoietin (EPO) deficiency is expected to result in anemia in diabetics. Upregulation of inflammatory cytokines is also expected to contribute to anemia.[5,6] Inflammation is expected to upregulate the release of hepcidin from liver which, in turn, decreases the absorption of iron from intestines resulting in deficiency of the mineral. Inflammation and associated pathway are believed to be the major factor responsible for pathophysiology of anemia in chronic diseases. Anemia associated with diabetes results in adverse influence on health and has wider implications on the human physiology. Diabetics having anemia are expected to have faster deterioration of renal functions which, in turn, lead to chronic kidney disease (CKD). Further, low levels of Hb in diabetics' result in less oxygen delivery to kidneys and thus are implicated in renal ischemia. The effects are multiple. Interestingly, decrease oxygen delivery to pancreas results in further decline of pancreatic functions and poor glucose control. Anemia appears to be unknown complication of diabetes with adverse effects on health. Low levels of Hb in diabetes are associated with greater decline in glomerular filtration rate and thus pose a risk for future CKD in such patients.Pancreatic beta-cell dysfunction has been linked with ischemia and oxidative stress caused by anemia.[7-10]

Importance of the study lies in the reports that 35% of diabetic progress to CKD and mortality of diabetics with anemia is more.[11,12] Thus, the present study was undertaken to find the presence of anemia in diabetics.

Aims and Objectives

The aim of the present study was to find the presence of anemia in diabetic and non-diabetic subjects visiting various outpatient departments (OPD) of Integral Institute of Medical Science and Research (IIMS and R), Integral University, Lucknow.

MATERIALS AND METHODS

The present study was a hospital-based cross-sectional study conducted in the Department of Physiology, IIMS and R. The subjects included in the present study were recruited from various OPDs of IIMS and R between January and June 2019. Both males and females in the age group of 30–60 years, attending the OPDs (mainly Medicine) of IIMS and R, Integral University, Lucknow, Uttar Pradesh, were included in the study. Subjects fulfilling inclusion (subjects attending OPDs, giving consent and willing to participate in study, those with type 2 diabetes as per the American Diabetic Association classification[13]) and exclusion (not giving consent, <30 years and more than 60 years of age, pregnant females, on medications like angiotensin-converting enzyme inhibitors) criteria were enrolled in the study.

Blood sample was collected under aseptic conditions from various OPDs using a disposable syringe under aseptic condition and was subsequently analyzed for various hematological parameters using automated analyzer (Beckman Coulter) in central pathology of IIMS and R and, Lucknow. Grading of anemia was done as per the WHO classification.[14] The study was approved by the Institutional Research and Ethics Committees of IIMS and R, Integral University, Lucknow.

Statistical Analysis

Data were presented as mean ± SD and were analyzed using the Statistical Package for the Social Sciences software (21.0) by applying unpaired *t*-test. $P < 0.05$ value was considered as statistically significant.

RESULTS

The present study included 92 subjects, attending various OPDs of the IIMS and R, Integral University, Lucknow, Uttar Pradesh. Out of 92 subjects, 48 (52.17%) were diabetic and 44 (47.83%) were non-diabetic [Table 1]. Among the diabetic group out of 48 subjects, mild, moderate, and severe anemia was present in 8 (Hb in g/dl was 11.25 ± 0.26), 11 (9.73 ± 0.83 g/dl Hb), and 4 (6.13 ± 1.15 g/dl Hb) subjects, respectively. In non-diabetic subjects, mild and moderate anemia was present in 5 (11.42 ± 0.33 g/dl Hb) and 7 (9.98 ± 0.83 g/dl Hb) subjects, respectively. Thus, in diabetics, 22.9% were having moderate anemia, and in non-diabetics, moderate anemia was present in 15.90% of subjects visiting OPDs [Tables 2 and 3]. In diabetics out of 48 subjects, 27 were female (56.25%) and 21 (43.75%) were male. Similarly, in non-diabetics, 28 (63.64%) were female and 16 (36.36%) were male. In the present study, the mean ± SD age (years) of diabetics and non-diabetics was found to be 44.17 ± 8.82 and 41.6 ± 8.80, respectively. The difference in mean ± SD values of Hb was found to be insignificant with $P = 0.167$. Similarly, insignificant differences were found between the mean ± SD values of blood indices, namely, mean corpuscular volume (MCV) ($P = 1.795$), mean

Table 1: Number and % of diabetic and non-diabetic subjects

Diabetics		Non-diabetics	
Number (*n*)	%	Number (*n*)	%
48	52.17	44	47.83

Table 2: Number and % of diabetic and non-diabetics as per the grades of anemia

Category as per Hb range (g/dl)	Diabetics (*n*=48)		Non-diabetics (*n*=44)	
	n	%	*n*	%
Normal	25	52.08	32	72.73
Mild anemia (11.0–11.9)	8	16.67	5	11.37
Moderate anemia (8.0–10.9)	11	22.91	7	15.90
Severe anemia (<8.0)	4	8.34	0	0

Hb: Hemoglobin

Table 3: Mean±SD value of Hb in diabetic and non-diabetic subjects as per the grade of anemia

Category as per Hb range (g/dl)	Diabetics (mean±SD)	Non-diabetics (mean±SD)
Normal	12.11±1.09	13.18±1.09
Mild	11.25±0.26	11.42±0.33
Moderate	9.73±0.83	9.98±0.83
Severe	6.13±1.15	8.97±0.15 (none were having severe anemia)

Hb: Hemoglobin

corpuscular Hb (MCH) (P = 0.897), and MCH concentration (MCHC) (P = 1.484), respectively, between diabetics and non-diabetics [Tables 4 and 5].

DISCUSSION

Diabetes is a major public health problem worldwide. Global burden of diabetes is increasing and is expected to be around 366 million by 2030. India by then is expected to be the diabetic capital of the world with maximum increase in the cases. Neural, cardiac, renal, and retinal complications are reportedly present (in decreasing order) in cases of diabetes which of course depend on the glucose control and duration of diabetes.[15]

Reports have suggested that as compared to non-diabetics, the occurrence of anemia is more common in diabetics. Reportedly, it is estimated that around one-fourth of the diabetic population suffers from anemia.In our study, 47.92% (23/48) of the diabetics were found to be anemic as compared to 55.5%in another study.[16] The difference in the results could possibly be due to lower sample size in our study. The duration of diabetes plays an important role in the development of anemia in diabetes. It has been reported in earlier studies that the risk of anemia is more if the duration of diabetes is more than half a decade.[17] In our study, 23 out of 48 diabetics were anemic and 12 out of 44 non-diabetics were anemic which indicate that in diabetics, anemia is more prevalent. Our results also confirm the results of studies which have shown that anemia is more prevalent in diabetics as compared to non-diabetics.[18,19]

Table 4: Gender-wise distribution in diabetics and non-diabetics

Variables	Diabetics (n = 48) (%)		Non-diabetics (n=44) (%)	
	Male	Female	Male	Female
Number	21 (43.75)	27 (56.25)	16 (36.36)	28 (63.64)

Table 5: Differences between diabetics and non-diabetics subjects

Parameter	Diabetic (*n*=48)	Non-diabetic (*n*=44)	*P*-value
Age (years)	44.17±8.82	41.6±8.80	Non-significant
Hb (g/dl)	11.56±2.20	12.56±1.54	0.167
MCV (fL)	87.88±10.54	90.94±4.90	1.795
MCH (pgm)	27.88±3.31	28.42±1.85	0.897
MCHC (%)	29.58±1.90	30.1±1.37	1.484

Hb: Hemoglobin, MCV: Mean corpuscular volume, MCH: Mean corpuscular hemoglobin, MCHC: Mean corpuscular hemoglobin concentration

In the present study, in diabetics out of 48 subjects, 27 were female (56.25%) and 21 (43.75%) were male. Contradictory reports regarding female gender as a risk for anemia in diabetics have also been reported in earlier studies.[20-22]

In diabetics, the mean values of Hb and blood indices, namely, MCV, MCH, and MCHC were non-significantly lower in diabetics as compared to non-diabetics. Results are in accordance with the study conducted by Aljohani *et al*. earlier. However, the results of the earlier study indicate that morphologically, the type of anemia in diabetics depends on the glycemic control.[23] A study done by Ali and Hassan found statistically significant increase in MCV of diabetics as compared to controls but no significant difference between MCH and MCHC values. The difference could possibly due to higher sample size used in the study by Ali and Hassan.[24] The results of the present study can be compared with earlier studies also. Hosseini *et al*. found that the prevalence of anemia was higher in females as compared to males, and moreover, most prevalent anemia was found to be normocytic and normochromic type.[25] The difference could possibly be explained on the basis of the researches which have reported that there appears to be negative impact of diabetes on Vitamin B12, folic acid, and iron metabolism and absorption. Moreover, certain drugs used in the treatment of diabetes also interfere in absorption of vitamins and minerals responsible for RBC and Hb synthesis and maturation.[4] The mean age of diabetics in the present study was higher which is similar to studies reported earlier.[26,27] Results of our study are in concordance with reports which have suggested that in developing countries, the majority of patients with diabetes are of age group ranging from mid-forties to mid-sixties.[28]

Severity of anemia in diabetes needs to be evaluated thoroughly. In the present study, moderate anemia was higher. It has been reported that there appears a direct relation

with decline in kidney functions and severity of anemia.[5] Similarly, correlation of the severity of anemia with glycemic control as indicated by glycated hemoglobin[29] is required, as poor glycemic control in diabetics further the development of anemia and upregulates its severity which, in turn, leads to more complications.

Limitations

The present study is not free from limitations. Anemia is a multifactorial condition and thus the major limitation is non-assessment of risk factors apart from diabetes in patients found to be anemic. Similarly, the duration of diabetes and blood glucose levels influences the occurrence of anemia in diabetics and thus needs evaluation. Kidney functions in diabetes require evaluation because anemia is found to be associated with CKD in diabetes.

Recommendations

Both anemia and diabetes are major public health problem in India with long-term negative impacts on the physiology of human body. Anemia in diabetes and diabetics with anemia, both way have serious implications. Diabetics who are anemic have progressive consequences such as neuropathy, nephropathy, retinopathy, and cardiovascular complications. Nephropathy in itself is a risk for developing anemia in diabetes which, in turn, further causes a decline in renal functions. Thus, it is recommended that every diabetic should be screened for the presence of anemia. Early diagnosis of anemia and timely corrective therapeutic measures are expected to slow the progression of complications, thus resulting in decline in morbidity and mortality associated with diabetes. Addressing the problem of anemia in chronic disease is importance, especially in the light of the fact that India is expected to be the "Diabetic Capital of World" in coming decade and at the same time as per reports 53% of females and around 23% of males are anemic in India.[30] Thus, serious efforts are required to address both the problems at individual and coexistent levels.

CONCLUSIONS

Anemia characterized by decline in RBC and Hb levels is associated with diabetes which, in turn, can itself result in anemia by virtue of multiple pathophysiological pathways such as inflammation and decline in EPO. Female gender and advancing age are risk factors for the development of anemia in diabetics. Similarly, morphological type of anemia in diabetics may vary. Majority were having moderate anemia and females suffered more from anemia as compared to males. The mean age was higher in diabetics and the values of Hb and MCV, MCH, and MCHC were non-significantly lower in diabetics as compared to non-diabetics. Thus, on the basis of the study, it may be concluded that female gender and the elderly are prone to anemia and thus are expected to be more prone to complications due to anemia in diabetes. The duration of diabetes is expected to influence the results and thus requires inclusion in the study design.

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