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Anemia its presence and severity in type 2 DM and its relationship with micro and macro vascular complications

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Abstract

Introduction: *In India, most diabetic patients are not being evaluated for anemia until appearance of clinical features of renal involvement. The aim of this study was to compare the prevalence of anemia in diabetic patients without overt features of renal pathology with non-anemic in diabetic patients and to analyze the severity of anemia in relation to the complications of diabetes and its duration.*

Material and Methods: *It is a cross-sectional study in which 120 patients of Diabetes Mellitus Type 2 was including attending Medical OPD of Mahatma Gandhi Hospital, Sitapura, Jaipur was included. Upon admission, all patients underwent a comprehensive assessment of diabetes-related complications and risk factors. Appropriate statistical analysis was done to find out any association between anemia and diabetes and its complications.*

Results: *Of the total 120 diabetic subjects in the study, 80 were anemic (49 males and 31 females) and 40 non anemic (26 males and 14 females). The results showed significant lowering of hemoglobin from 3 years of duration of diabetes. Neuropathy (73.75%), retinopathy (40%) and CVA (11.25%) and CAD (18.75%) were more prevalent in anemic group than non-anemic group. Incidence of Neuropathy and Retinopathy increases with increase in severity of anemia whereas micro albuminuria had reverse characteristic. CAD, PVD and CVA incidence were found maximum in the moderate anemia group. Severity of anemia increases the mortality risk in coronary artery disease (ischemia) as predicted by TIMI score.*

Conclusion: *These finding suggest that anemia is associated with both micro and macro vascular complications in Diabetes. Anemia should be considered for inclusion in routine management of Type 2 DM patients and should be treated to minimize and further delay the complications, thus enhancing quality of life.*

Introduction

Diabetes mellitus (DM) is a metabolic disorder of great impact worldwide. With respect to the global prevalence the greatest absolute increase in the number of people with diabetes will be in India with a projected estimate of 79.4 million in the year 2030 from 31.7 in 2000.[1] Diabetes is a highly disabling disease, which can cause blindness, amputations, kidney disease, anemia, and cardiovascular and brain complications, among others, impairing the functional capacity, autonomy and individual quality of life.[2] With the prevalence rate increasing in the younger age groups [3,4] the long term complications of diabetes

can be expected to occur during their productive years causing severe economic and social burden.[5] Another chronic condition which affects the quality of life is anemia. Anemia, a common complication, is more prevalent in persons with diabetes than in persons without diabetes.[6] Anemia also develops earlier and is more severe in patients with diabetes than in patients with renal impairment from other causes.[7] The World Health Organization (WHO) guidelines recommend investigation of anemia when the Hemoglobin is less than 12g/dl in women and less than 13g/dl in men.[8] Anemia has been associated with the development and progression of both micro vascular and macro vascular complications of diabetes.[6] Anemia can lead to falsely low HbA1c levels, which may result in under treatment of hyperglycemia, which in turn will contribute to the progression of both micro vascular and macro vascular diabetic complications.[9]

The occurrence of anemia in diabetics was earlier attributed to renal pathology but studies have shown that anemia develops earlier in patients with diabetes when compared to patients with renal involvement due to other causes.[10] The Reduced hemoglobin levels independently identify diabetic patients with an increased risk of micro vascular complications, cardiovascular disease and mortality. Moreover diabetics who already have reduced exertional capacity, poor wound healing or co-morbid vascular disease, anemia constitutes an unwelcome additional burden. Correction of anemia certainly improves performance and quality of life in diabetic patients.[11] In India diabetic people are not assessed for the anemia until the renal pathology supervenes as a complication.

Patients with diabetes may be more vulnerable to the effects of anemia due to co-existent significant cardiovascular disease and hypoxia-induced organ damage. Hemoglobin levels may be linked to the risk of cardiovascular events, hospitalization, and increased mortality.[12] Anemia has been associated with more adverse outcomes among diabetics. These include cardiovascular complications like left ventricular hypertrophy and congestive heart failure.[12] Studies have proved that correction of anemia improves cardiac function. The possible mechanism is by reduction of exercise-induced myocardial ischemia.[13]

Also reports on relationship of duration of diabetes on anemia are scarce despite the prevalence of diabetes-related anemia and its recognized consequences. As a result, the relation between anemia and vascular complications in patients with type 2 diabetes mellitus (T2DM) remains unknown. We designed a cross-sectional study to assess the occurrence and severity of anemia with micro- and macro vascular complications in T2DM patients without overt features of renal pathology who regularly attend the hospital for blood glucose estimation.

Material and Methods

This is cross sectional study, in which 120 subjects with diabetes mellitus type 2 were included in the study attending Medical OPD of Mahatma Gandhi Medical Hospital, Sitapura, Jaipur.

Exclusion Criteria

- Patients excluded from the study with obvious cause of anemia such as thalassemia, ESRD, chronic inflammatory disease, rheumatoid arthritis, infection, pancreatitis, hemolysis, acute or chronic blood loss such as history of hemorrhoids, any bleeding disorder and history of blood transfusion.
- All type 1 diabetes patients.
- Known case of Ischemic Heart Disease taking Antiplatelet drugs.

Presence of diabetes mellitus was defined as per American Diabetes Association Criteria.[2015] Presence of chronic kidney disease defined by National Kidney Foundation Criteria. BMI calculated as per latest WHO guidelines. Anemia was considered as Hb < 13 g/ dL in men and < 12 g/dL in women as per WHO standards.

Diabetic complications and co-morbidities: Upon admission, all patients underwent a

comprehensive assessment of diabetes-related complications and risk factors. The Diabetic Neuropathy (DN) was classified according to albuminuria urine test and GFR Estimation by MDRD Formula. The patient was considered normo albuminuric if 24 hour Albumin excretion was less than 30mg/g, micro-albuminuria if it was between 30–300 mg/g and macro-albuminuria if it was above 300 mg/g. Macro albuminuric were excluded from the study. Diabetic Neuropathy (DPN) assessment was done by Michigan Neuropathy Screening Instrument. Score above two was indicative of neuropathy presence. To assess diabetic retinopathy (DR), all patients were referred to an ophthalmologist and the degree of eye involvement including proliferative and non-proliferative diabetic retinopathies was determined. Ophthalmologic examination was done using fundoscopy with dilated pupils. . Coronary artery disease (CAD) was considered to be present if the patient had typical ischemic history or ECG changes suggesting ischemia. Cerebrovascular disease (CVD) was diagnosed based on the presence of either transient ischemic attack or stroke. Peripheral arterial disease was defined by history of claudication pain and assessment of Ankle – Brachial Index. DR, DN and DPN were considered as diabetic micro vascular complications, while CAD, CVD and PVD were considered as diabetic macro vascular complications.

Ethical Considerations: The study was conducted in Mahatma Gandhi Hospital and was approved by the Ethics Committee University of Medical Sciences. The purpose of the study was explained to all participants.

Statistical analysis: Statistical analysis was performed using SSPS statistical software (SSPS version 21. Inc, Chicago, IL, USA). Patient demographics were reported as mean and standard deviation for continuous variables and percentages for categorical variables. Chi- square was used to compare categorical variables and independent sample t-test was used to compare continuous variables among the two groups. Statistical significance was defined at a level of 5% ($p < 0.05$). The generation of graphs and tables etc. was done by using the Microsoft word and excel software.

Results

Of the total 120 diabetic subjects in the study, 80 were anemic (49 males and 31 females) and 40 non anemic (26 males and 14 females). The mean age of anemic group was 60.33 ± 14.18 years and that of non-anemic 55.58 ± 13.73 years. In the Anemia group, maximum i.e. 24 patients (30%) were between the age group of 61-70 years, while in control group 12 patients (30%) were in the age group of 51-60 years. The general characterstics of the study population is described in table 1. Mean BMI in case group was higher than the control group and the difference was statistically significant ($p = 0.038$). Also the mean Systolic Blood Pressure was higher in anemic group.

Table 2 shows the hematological parameters of the blood samples we analyzed that were obtained from the study participants. Hb concentration was observed to be significantly decreased in the cases as compared to the controls. Mean Hb concentration was 8.06 ±1.44 g/dl (8.12 g/dl in males and 7.96 g/dl in females). The Serum Iron level was significantly lower in the cases than the controls. Ferritin and total iron-binding capacity (TIBC) levels were found to be in lower range as compared to the control group.

Table- 1: General characteristics of the study groups

Variables	Group-A (anemia)	Group-B (non-anemia)	p-value/x^2(df)
Gender • Male • Female	 49 (61.25%) 31 (38.75%)	 26 (65%) 14 (35%)	
Age (in yrs)	61.44 ± 13.27	55.58 ± 13.73	0.028*
Duration of Diabetes	13.06 ± 10.13	6.53 ± 6.65	0.000***
BMI (kg/m^2)	27.11 ± 4.60	25.51 ± 3.56	0.038*
SBP (in mmHg)	136.05 ± 14.34	129.90 ± 10.46	0.008**
DBP (in mmHg)	86.33 ± 8.11	81.80 ± 10.18	

*Values presented as Mean± SD or No. (%)
*Test applied chi-square; student t test
Significance p<0.05;**p<0.01;***P<0.001

Table-2: Comparison of biochemical profile of the study groups

Variables	Group-A (anemia) (n=80)	Group-B (non-anemia) (n=40)	*P* -Value
Anemia Parameters			
Hemoglobin (g/dl)	9.18 ± 1.55	13.32 ± 0.74	0.000
HbA1c (%)	8.06 ±1.44	7.78 ± 1.17	0.256
S. Iron	43.60 ± 23.68	61.98 ± 29.38	0.001
TIBC	291.79 ±86.77	317.33 ± 76.36	0.102
S. Ferritin	189.49 ± 130.95	217.80 ± 126.44	0.256
S. Vitamin B_{12}	313.31 ±183.00	321.35 ± 162.29	0.807

Table 3 shows trend in change of hematological parameters with duration of diabetes. To find the earliest duration of diabetes which could cause statistically significant low mean hemoglobin levels, different combinations of duration of diabetes were formed as subgroups and multiple comparisons were done for the various combinations. Statistically significant results were obtained with the subgroup combination - up to 3 years, 3 - 10 years and more than 10 years. The results showed significant lowering of hemoglobin from 3 years of duration of diabetes. The Mean Iron levels also progressively declined and the difference was statistically significant. Also the Mean TIBC levels showed decline as the duration of diabetes increased. The results were different for males and females (Table 4).

Table 3: Comparison of different parameters of Anaemia in the case group with duration of Diabetes

Variables	Anemia (n=80)			p-value
	< 3 years (n=18)	3- 10 years (n=20)	>10 years (n=42)	
Hb	9.80 +1.88	9.44+1.41	8.78 +1.36	0.040*
HbA1c	8.69 +1.51	7.84+ 1.34	7.90+1.41	0.108
Serum Iron	51.67 +31.67	49.40 +26.38	37.38 +16.05	0.0438
TIBC	360.83 +71.89	357.25 +61.05	231.02 +51.69	0.000***
Serum Ferritin	216.29 +134.28	166.98 +147.64	188.72 +122.06	0.515
Serum Vitamin B_{12}	320.11 +196.12	308.2 +188.41	312.83 +179.14	0.980

- Test applied-ANOVA
- Significance* p<0.05;**p<0.01;***P<0.001

Table 5 shows micro and macro vascular complications respectively in the study group. Out of 80 patients in group A, 73.75% patients had neuropathy, 40 % had retinopathy and 83.75 had micro albuminuria. Neuropathy was more prevalent in the anemic group (59 cases – 73.75%) as compared to control population (16 patients – 40%) followed by retinopathy which showed

statistically significant difference. Occurrence of CVA showed significant difference in control and the case group. Diabetic patient with anemia were found to have Myocardial Ischemia (18.75%) compared with patients without anemia (12.5%). Nine diabetic patients with anemia (11.25%) had stroke compared with 2 (5%) patients without anemia. (Table 5). Table 6 demonstrates the prevalence of micro and macro vascular complications with the duration of diabetes. Maximum complications was observed after the period of >10 year duration group.

Table 4: Comparison of different parameters of anemia in male and female subjects with duration of diabetes

Variables		Duration of Diabetes (in years)		
		< 3 years	**3- 10 years**	**>10 years**
Hb	MALE	10.35 +1.80 (n=7)	9.64 + 1.39 (n=14)	9.23 + 1.30 (n=28)
	FEMALE	9.45 +1.93 (N=11)	8.98 + 1.45 (n=6)	7.89 + 1.01 (n=14)
S. Iron	MALE	57.71 +19.65	54.21 +21.80	42.82 +12.55
	FEMALE	47.81 +37.84	38.16 +34.52	26.5 +17.16
TIBC	MALE	325 +38.40	347.14 +54.90	230.28 +49.34
	FEMALE	383.63 +80.19	380.83 +73.31	232.5 +58.04

Table 5: Comparison of micro vascular complications of the study groups

	Type of Complication	**Group-A (anemia) (n=80)**		**Group-B (non-anemia) (n=40)**		***p-value***
		No. of subjects (n)	**%**	No. of subjects (n)	**%**	
Microvascular Complications	Retinopathy	32	40	6	15	0.005**
	Neuropathy	59	73.75	16	40	0.000***
	Micro albuminuria	52	65	22	55	
Macrovascular Complications	Myocardial Ischaemia	15	18.75	5	12.5	0.386
	PVD	3	2.5	1	2.5	0.719
	CVA	9	11.25	2	5	

- Test applies-Chi-square test
- Significance* p<0.05;**p<0.01;***P<0.001

Table 6: Complications with duration of Diabetes

Complications	**Duration of Diabetes (in years)**			**Total**
	< 3 years (n=18)	3- 10 years (n=20)	>10 years (n=42)	
Retinopathy	0	0	32	**32**
Neuropathy	12	12	35	**59**
Microalbuminuria	12	12	43	**67**
CVA	1	2	6	**9**
MI	2	3	10	**15**
PVD	0	1	2	**3**

Severity of anemia was correlated with the complication both micro and macro vascular (Table 7). Incidence of Neuropathy and Retinopathy increases with increase in severity of anemia whereas micro albuminuria had reverse characteristic. CAD, PVD and CVA incidence were found maximum in the moderate anemia group.

Table 7: Severity of Anemia with complications of Diabetes

Hemoglobin	Neuropathy	Retinopathy	Micro albuminuria	CAD	CVA	PVD
Non Anemic	16	6	22	5	2	0
Mild Anemia N = 25	14 [56%]	7 [28%]	21 [92 %]	4	0	0
Moderate Anemia [n = 49]	39 [79.59%]	22 [44.89%]	41 [83.67%]	10	9	3
Severe Anemia N = 6	6 [100%]	3 [6] [50%]	4 [66%]	1	0	0

Table 8: Severity of Anemia with Cardiovascular mortality assessment by TIMI score

Hemoglobin	STEMI	NSTEMI	TIMI (AVG)
Mild Anemia (4)	3	1	4.5
Moderate Anemia (10)	8	2	6
Severe Anemia (1)	1	-	9
Non Anemic (5)	4	1	4.4

Discussion

In this study we have tried to compare the severity of anemia with the complications of diabetes excluding patients of overt nephropathy (CKD grade IV, V or macro albuminuria) and also correlate the duration of diabetes with occurrence of anemia and its complications.

The prevalence of diabetes mellitus is rising rapidly at a steep pace all over the world particularly in India. The International Diabetes federation (IDF) estimates the total number of diabetic subjects to be around 40.9 million in India in 2006 and this is further set to rise to 69.9 million by the year 2025 (Mohan et al.).[14] Anemia is commonly associated with diabetes and potentially contributing to the pathogenesis of diabetes comlications.[15]

In our study, the case cohort consists of 120 diabetic subject out of which of 80 case subjects were anemic (male 61.25% and female 38.75%) and 40 controls were non anemic (male 65% and female 35%). In the anemic group, maximum patients i.e. 24 (30%) belong to the age group 61-70 years. Trevest et al. suggested that anemia is prevalent in elderly diabetics.[16]

A previous study reported a 15.3% incidence of anemia in participants with diabetes without renal insufficiency.[17] The study added that patients who have poorly controlled diabetes were at greater risk of anemia then those with controlled diabetics. Another study reported that 7.2% of diabetics with normal renal function had anemia.[18]

In this study, there was a high prevalence of over-weight, and the mean BMI in anemic patients was significantly higher when compared to the non-anemic group (p=0.038). Obesity is associated with the development of an inflammatory state especially in adipocytes and muscle cells thus leading to increase circulation of blood glucose resulting in hyperglycemic state.[19] Adipose tissue has more recently been recognized as a metabolically active organ system linking the endocrine and immune systems; furthermore it a source of variety of cytokines.[20]

It was also found in our study that the systolic BP and diabetic BP in diabetic patients that were anemic was significantly higher when compared to non-anemic cases. This association is of concern considering that Hypertension in DM increases the risk of cardiovascular complications such as heart failure, stroke, atherosclerosis and tissue inflammation.[21]

According to Ximenes et al.[22] anemia is a prevalent co-morbidity in patients with HTN and when present, patients have more severe symptoms and worse functional capacity as well as increased mortality. The knowledge that anemia worsens the symptoms of hypertension is not new but recently, the magnitude of anemia association with this disease has become more evident. The main causes that contribute to anemia in patients with HTN are nutritional

deficiencies especially iron and chronic inflammation. In the present study, the low levels of Hb in anemic group was found to be associated with lower levels of serum iron. Also the total Iron binding capacity in anemic group was found to be at lower limit of normal range, characteristic of anemia of chronic disease (ACD). ACD is immune driven; cytokines and cells of reticulo endothelial system induce changes in iron homeostasis, proliferation of erythroid proginator cells, production of erythropoietin, and life span of RBCs, all contributing to pathogenesis of anemia. Erythropoiesis can be affected by disease underlying anemia of chronic disease through the infiltration of tumour cells into bone marrow or micro-organism.[23]

Diabetes mellitus is a chronic inflammatory state with increased levels of pro inflammatory cytokines even before development of renal impairment. Etiopathogenesis of anemia in diabetes is multifactorial. Erythropoietin (EPO) deficiency as a result of diabetic neuropathy is most important cause of anemia in patients with diabetes.[24]

However even before any functional or organic deficiency of EPO is evident, several other factors may contribute to the development[25] of a chronic hypoxic milieu, promoting erythropoietic stress and potentiating the genesis of early anemia in diabetes. Moreover, autonomic neuropathy can decrease sympathetic stimulation of erythropoietin production through renal denervation.[26]

Tissue that are responsible for synthesis of erythropoietin have reduced renal response to hypoxia due to the effect of diabetes mellitus. Also decrease in androgenic hormone (eg. Testosterone) lowers stem cell production in bone marrow and erythropoietin synthesis in kidneys. An important cause of resistance to erythropoietin is the inflammation accompanied by the rise of cytokines and consequent suppression of erythrocyte stem cell proliferation. The study suggested that before development of nephropathy, overt inflammation associated with diabetes may culminate erythropoietin suboptimal response[27]systemic inflammation[28] and changes in the renal tubule interstitium disrupting the interaction between interstitial fibroblasts, capillaries and tubular cells required for normal hemopoietic function, also leads to anemia.[29]

In the present study, we found significant relation between duration of diabetes and severity of anemia. As the duration of diabetes increased, the fall in Hb level in anemic group progressed significantly further (p=0.040). The reduction in Hb was more marked in females as compared to males in case group. The decrease in Hb levels was accompanied by significant reduction in serum iron levels (p=0.438) and total iron binding capacity (p=0.000). Also females in the study group comprised of lower iron levels and high TIBC in comparison to males indicating the presence of iron deficiency state along with ACD. The possible reason could be due to higher prevalence of iron deficiency in Asian countries especially in women.[30]

Other possible reason could be that most of the patients that presented belong to the lower socioeconomic class who frequently have nutritional deficiencies, lack of awareness and inability to access appropriated health care due to financial constraints.

The mean duration of diabetes of 13.06 years in anemic group indicates long duration of diabetes and thus higher incidence of diabetic complications.

Neuropathy was the most prevalent micro vascular complication in our study (73.75%) which was significantly higher in anemic group as compared to control group (p=0.000) followed by retinopathy (40%) which was also statistically significant. Diabetic neuropathy is one of the most common complications of long standing and fairly uncontrolled diabetes. The prevalence of neuropathy varies widely from 5.4% - 72% in different studies[31,32] owing to different criteria used to define neuropathy. On one hand anemia may be due to deficient production of EPO due to autonomic dysfunction and on other anemia may potentiate autonomic nerve injury by hypoxic

insult. Ranil et at[33] found that anemia to be a risk factor for presence and severity of diabetic retinopathy. Quing quio. et al[34] reported odds of 2.0 for the presence of diabetic retinopathy in indivisuals with anemia (Hb < 12mg/dL) in cross sectional study of 1691 diabetic patients. In our study the incidence of retinopathy was found in subjects with diabetes of >10 years duration. In our sample, 65% of the anemic patients had micro albuminuria, and 21 cases and GFR < 60 ml/min. The mean GFR of anemic patient was 75.08 ml/min. Anemia becomes increasingly common as GFR declines below 60 ml/min/1.73m2.[35-37]

As mentioned earlier, it may occur due to destruction of peritubular fibroblasts and decrease in EPO levels even before detectable reduction in GFR.[38,26] The incidence of micro albuminuria increase significantly with the longer duration of diabetes.

According to our study, the incidence of retinopathy and neuropathy increases with the severity of anemia in diabetic population in contrast the incidence of micro albuminuria decreases with severity of anemia possibly due to increase in overt nephropathy progression as anemia worsens which was excluded from the study.

In our Type 2 diabetic mellitus population, the prevalence of macro vascular disease was higher in anemic group than those without anemia but the finding were not statistically significant. Also these finding were not in concordance with other studies that was done[39,40,41,42] which suggests that anemia is an independent risk factor of macro vascular disease. One study by Burell LM et. al.[42] showed that anemia was a potent adverse risk factor for new onset cardiac failure while other showed that anemia was a potent adverse risk factor for new onset cardiac failure while other showed that anemia was a prognostic marker for poor outcomes in patients with established cardiac dysfunction.[43]

It was suggested that the increase prevalence of anemia in diabetes patients may contribute to their worse prognosis of heart failure compared to non-anemic and also non diabetics with anemia by Dries DL et al.[44]

It is well known that diabetes leads to atherosclerosis (macro vascular complication) which impedes the blood flow to the tissues. Association of anemia further leads to hypoxia by reduction in oxygen carrying capacity of blood, by increase in cardiac workload and stimulation of sympathetic activity.

In our study, the result were not significant which may be possible due to cross sectional design of the study. It is possible that unknown factors confounded the results. Also due to the exclusion criteria of patient taking antiplatelet drugs, the cohort of macro vascular complications was very small as compared to the total case group. Both anemia and DM are recognized as strong independent risk factors for mortality and recurrent ischemia after acute MI.[45,46] Anemia is 2-3 times more common in indivisuals with DM compared to those without DM[6]. Recent studies have shown that anemia is associated with increased short term mortality in patients with IHD.

In our study, we assessed the mortality of the CAD patients with TIMI score. We concluded that as the severity of anemia increases, the TIMI score rises i.e. Risk of mortality increases. The study was conducted by David H shu et al.[47] which stated that combination of diabetes and anemia was associated with a significant risk of death over 36 months, with almost 65% patients dying by 36 months. Anemia is shown to be well tolerated in normally functioning heart. The increase in cardiac output via a higher heart rate, larger stroke volume and decrease in blood viscosity compensates for the decreased oxygen carrying capacity of blood.[48,49] These compensatory mechanisms are mediated partially through activation of the sympathetic nervous system, which has been shown to be deleterious in CKD.[50] Also because of anemia there is decrease in diastolic filling time causing reduced supply to the coronaries, thus increasing the chances of ischemia. Anemia in presence of fixed coronary

artery stenosis reduces the ability of the heart to increase cardiac output and there by results in left ventricular dysfunction.[51] Exacerbation of left ventricular dysfunction or ischemia by anemia in post MI patient may be partially responsible for the excess long term mortality.

Our study had few limitations

Firstly the time period between the onset of anemia and diabetes duration is not known and therefore when to screen for anemia, the answer remains still unknown. Secondly the sample size of the study was small especially for macro vascular disease lead to inconclusive results. Large sample size could have led to better results.

There are evidences suggesting that erythropoietin (EPO) levels in patients with diabetes and anemia are inappropriately low compared to patients with Iron Deficiency Anemia.[52] EPO deficiency occurs earlier in patients of Diabetic Neuropathy compared to the other caused of diabetic nephropathy, and this may be due to the autonomic neuropathy leading to sympathetic denervation of the kidney.[52,26,53] Trial such as ACORD[54] (Anemia Correction in Diabetes) are undergoing for role of EPO in anemia which may reveal the cause of anemia and benefits on complications.

Conclusion

Anemia is very commonly associated in patients of diabetes and is seen in people with normal renal function. So they have a further role in development of both micro and macro vascular complications. Moreover anemia leads to false low estimation of HbA1c causing poor control of diabetes. Also severity of anemia increases the mortality risk in coronary artery disease (ischemia) as predicted by TIMI scoring. Anemia should be considered for inclusion in routine management of Type 2 DM patients and should be treated to minimize and further delay the complications, thus enhancing quality of life.

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