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To study the influence of iron deficiency anaemia on hba1c in diabetic screening

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Abstract
Introduction: HbA1c is used for monitoring glycaemic control and to predict diabetic complications. IDA attributes to 50% of all forms of anaemia, globally. Reduced iron stores have a link with increased HbA1c, leading to false-high values of HbA1c. There is lack of clinical evidence suggestive of the influence of Iron Deficiency Anaemia on HbA1c.
Objectives: To evaluate the association between Iron Deficiency Anaemia and HbA1c values.
Methodology: Observational Cross-sectional study was conducted on 50 patients attending OPD/admitted to MVJ Medical College & Research Hospital, during the study period from January 2018 to December 2018. By Simple Random Sampling, patients with anaemia, normal fasting and postprandial plasma glucose levels, normal liver function tests, normal blood urea and serum creatinine levels were recruited for this study.
Results: Twenty-Five participants were in the iron deficiency anaemia group and 25 in the control (normal) group. Mean Hb among cases was 8.48±1.5 (5.4 to 10.9 gm dL) and that among controls was 14.2±0.8 (12.3-15.5 gm/dL). The mean HbA1c was 6.5±0.6. The mean HbA1c for cases with Iron Deficiency Anaemia was more than that for healthy controls (7.1±0.3 and 6.0±0.3 respectively) (p-value <0.0001).
Conclusion: Iron deficiency was associated with higher proportions of HbA1c. Which could cause problems in the diagnostic and therapeutic interpretation of the HbA1c concentrations. Hence, the iron status must be considered during the interpretation of the HbA1c.

Keywords: Iron deficiency anaemia, glycosylated haemoglobin, non-diabetics

Introduction

To Study the Influence of Iron Deficiency Anaemia on Hba1c in Non Diabetic Patients Glycated haemoglobin, HbA1c is the "gold standard" for monitoring glycaemic control and is been used as a predictor of diabetic complications since 1980s [1, 2]. HbA1c measurements correlate with mean serum glucose determinations over time; Glycated haemoglobin results from post translational changes in the haemoglobin molecule, and their levels correlate well with glycaemic levels over the previous six to 10 weeks [3]. Being a valid and reliable index of glycaemic status, high concentrations of HbA1c is highly specific for diabetes. HbA1c has also been recommended as a diagnostic test for Diabetes Mellitus by the American Diabetes Association (ADA 2013) [4]. Logistically, HbA1c requires a non-fasting random sample and is more advantageous compared to conventional oral glucose tolerance test, which requires a fasting sample [5]. Iron deficiency anaemia is one of the major public health problems in India. Being one of the common forms of malnutrition, it attributes to 50% of all forms of anaemia, globally. It's been found previously that reduced iron stores have a link with increased HbA1c, leading to false-high values of HbA1c in non-diabetic individuals [6]. Its alteration in other conditions such as haemolytic anaemia, hemoglobinopathies, pregnancy, and vitamin B12 deficiency has been explained in a study conducted by Sinha *et al.* [7]. In a study conducted by Rajendra Prasad Parlapally among 63 non-diabetic, anemic patients, and 63 age-matched healthy subjects found that the mean HbA1c (6.13%±0.6%) level in the patients with iron deficiency anaemia (IDA) was higher than that in the control group (5.12% ± 0.5%) (P<0.001), thus concluding IDA was associated with shift in the HbA1c levels to higher side, primarily between 6.0% and 6.5% [8]. Another study done to find the effect of iron deficiency anaemia on the levels of haemoglobin $A1_C$ in non-diabetic patients by Coban

E has concluded that in patients with IDA, HbA1c decreased significantly after iron treatment from a mean of 7.4% ±0.8 to 6.2% ±0.6 (p<0.001); hence Iron deficiency must be corrected before any diagnostic or therapeutic decision is made based on HbA1c [9]. Omer Tarim studied the effects of iron-deficiency anaemia on haemoglobin A1C in type 1 diabetes mellitus and found that Patients with IDDM had higher levels of HbA1c than those in the control group (P<0.001) and after iron supplementation, HbA1c decreased from a mean of 10.1±2.7% to a mean of 8.2±3.1% (*P*<0.05). Additionally HbA1c in ID non-diabetic patients decreased from a mean of 7.6±2.6% to 6.2±1.4% after iron therapy (*P*<0.05).

Justification of the study: Even though iron deficiency anaemia is the most common nutritional deficiency, the clinical evidence suggestive of the influence of Iron Deficiency Anaemia on HbA1c is inconsistent. HbA1c is widely used as an important marker of glycaemic control, and it is of utter importance to exclude factors which could spuriously elevate its levels. Hence, this study is been proposed in iron-deficient individuals with normal fasting blood sugar (FBS) and post postprandial blood sugar (PPBS) levels to assess whether anaemia has any effect on HbA1c levels, and anaemia should be considered before making any therapeutic decisions based solely on HbA1c levels.

Objective: To evaluate the association between iron deficiency anaemia and HbA1c values

Materials and Methods: Design of Study
Observational Cross-sectional study
Period of Study: 1 year (January 2018 to January 2019)

Study Setting: Department of General Medicine, Pathology, Biochemistry, MVJ Medical College & Research Hospital, Bangalore.

Source of Data: The study will be conducted on 50 patients attending OPD/admitted to MVJ Medical College & Research Hospital, during the study period from January 2018 to January 2019.

Sample Size: 25 non diabetes patients with iron deficiency anaemia and 25 controls at MVJ Medical College & Research Hospital, Bangalore.

Sampling Technique: Simple Random Sampling

Inclusion Criteria: Presence of anaemia as defined by WHO Hb: <13.0 g/dl (adult males) <12.0 g/dl (non-pregnant women, Microcytic, hypo-chromic picture in peripheral blood smear, Normal fasting and postprandial plasma glucose levels, Normal liver function tests, Normal blood urea, serum creatinine levels.

Exclusion Criteria: Confirmed cases of diabetes mellitus (using two or more of the following: presence of symptoms related to diabetes, fasting blood glucose, 2 hours postprandial glucose, and oral glucose tolerance test), Hemoglobinopathies, Haemolytic anaemia, Chronic alcohol ingestion, Chronic renal failure, Pregnant females, Documented past history of gestational diabetes (GDM), History of Blood loss or blood transfusion in the past 3 months, Documented history of endocrinopathy with affect for glycaemic control, Current or prior use of medication with potential to increase or decrease HbA1c, Haemoglobin concentration <6 g/dl or >16g/dl.

Study Tool: A pre-designed proforma was used to collect information of the study participants. The proforma had questions to collect information about the socio-demographic details of the participants, clinical history and signs suggestive of Anaemia. Proforma also had details of estimated lab parameters like Complete Hemogram, Fasting and Postprandial blood Sugars and HBA1C.

Anticipated Outcome: Iron deficiency Anaemia will increase the HbA1C values among non-diabetic patients.

Data Collection: Informed consent will be obtained from all patients to be enrolled for the study. In all the patients relevant information will be collected in a pre-designed proforma. The patients are selected based on clinical examinations and laboratory tests.
Adult patients aged more than 21 years of age attending the outpatient clinics of Department of Medicine of MVJ Medical College & Research Hospital were screened by Pathology department for anaemia as defined by WHO guidelines. Patients identified with iron deficiency anaemia based on Haemoglobin values, MCV, MCHC, peripheral smear after satisfying the inclusion criteria will be enrolled for the study.

Statistical Analysis: The collected data will be entered in Microsoft Excel spreadsheet and analysed using Statistical Package for Social Sciences (SPSS) version 17. The analysis of data was carried out by entering the code information and generating tables. The data will be presented using descriptive statistics in form of tables and graphs. Results are expressed as proportions with 95% confidence interval. Univariate analysis was carried out using non-parametric Mann Whitney Test to compare the HBA1c values between two groups.

Laboratory Investigations: Complete Hemogram, Peripheral blood smear, Liver function test, renal function test, Fasting and Post postprandial blood Sugars, HbA1c.

Collaborating Departments: Department of Pathology, Biochemistry of MVJ Medical College.

Conflict of Interest: Nil

Results and Interpretation
A total of 50 patients attending General Medicine OPD/IP of MVJ Medical College and Research Hospital were recruited for the study, of which 25 were in the iron deficiency anaemia group and 25 in the control (normal) group. Of the 50 subjects, 23 (46%) of them were in the age group of 20-39 years, whereas 23 (46%) were in the 40-59 years and remaining 4 (8%) were more than 60 years In the 20-39 years age group there were about 11 (44%) cases and 12 (48%) controls. In 40-59 years category there were 13 (52%) cases and 10 (40%) controls whereas, in age group 60

years, there was one (4.0%) case and 3 (12%) controls. The mean age of cases was 40.3±10.7 years and mean age of controls was 38.4±12.9 years.

Table 1: Comparison of Age in Case (IDA) and Control (Healthy)

Age in years	No. of cases	No. of controls	Total
20-39	11 (44%)	12 (48%)	23
40-59	13 (52%)	10 (40%)	23
≥60	1 (4.0%)	3 (12%)	4
Total	25	25	50

Table 2: Mean of Age in Case (IDA) and Control (Healthy)

	Mean age in years	Standard deviation
IDA	40.3	10.7
Normal	38.6	12.9
Total	39.4	11.8

Among the study participants, there were 27 (54%) females and 23 (46%) males. There were 15 (60%) females and 10 (40%) males in the cases and 12 (48%) females and 13 (52%) males in the controls.

Table 3: Sex wise distribution of Cases (IDA) and Control (Healthy) n = 50

Gender	No. of cases	No. of controls	Total
Female	15	12	27
Male	10	13	23
Total	25	25	50

Table 4: Age and sex-wise distribution n=50

Age in years	Male patient n (%)	Female Patients n (%)	Total n (%)
20-39	10 (37.0%)	13 (56.5%)	23 (46%)
40-59	14 (51.9%)	9 (39.1%)	23 (46%)
> 60	3 (11.1%)	1 (4.3%)	4 (8%)

Presenting symptoms among patients with Iron Deficiency Anaemia was enquire using proforma. Symptoms related to IDA like Fatigability, Dyspnoea on Exertion, Fever, Dizziness, Gastrointestinal Blood Loss and Palpitations were asked and depicted. Fatigability was found to be the most common symptom in 22 (88%) of cases, followed by Dyspnoea on Exertion in 11 (44%) cases.

All the patients were subjected to clinical examination and signs related to IDA were assessed. The most common sign was found to be pallor (100%), followed by platynychia/ Koilonychia in 9 (36%) cases and Bald Tongue in 7 (28%) cases.

Complete Hemogram including Haemoglobin (gm/dL), Haematocrit (%), Mean corpuscular volume (MCV) (fL), Mean corpuscular Haemoglobin (MCH) (pg) and Serum Ferritin were estimated for all the cases and controls. The range of Haemoglobin among study participants is from 5.4 gm/dL to 15.5 gm/L Mean Haemoglobin among cases was 8.48±1.5 (5.4 to 10.9 gm/dL) and that among controls was 14.2±0.8 (12.3-15.5 gm/dL).

Mean Hb among males in case group was 9.3±1.41 gm/dL and that of healthy controls was 15.7±1.01 gm/dL. Likewise Mean Hb among females in case group was 7.9±1.43 mg/dL and that of healthy controls was 12.6±0.51 m/dL. These values evidently prove that Hb was lower in anemic patients than in healthy controls, and the observed difference was statistically significant (Chi-square test P<0.001).

Table 5: Mean Haemoglobin among cases and controls n= 50

	Case	Controls
Male	9.3	15.7
Female	7.9	12.6
Total	8.48	14.2

Among cases, 15 (60%) were having moderate anaemia with Hb between 8-10 g/dL, while 9 (36%) were having severe anaemia (Hb < 8 g/dL). One patient had mild anaemia with Hb value between (>10-12 gm/dL). Among those with severe anaemia, 7 (28%) were females and 2 (8%) were males and in moderate anaemia, 8 (32%) were females and 7 (28%) were males. One male patient (4%) has mild anaemia.

Table 6: Severity of Haemoglobin among cases n=25

Haemoglobin (g/dl)	Number	Percentage
Severe <8	9	36
Moderate 8-10	15	60
Mild >10-12	1	4

On comparing the Mean haematocrit among cases and controls, that among cases was found to be 30.7±1.6 and in controls was 40.6±44 whereas total mean haematocrit was found to be 35.6±6.0. Mean Corpuscular Volume (MCV) for cases was low (74.4±2.8) than that for controls (89.6±2.9) with a total mean of 82.0±8.2. A total mean MCH of 26.6±4.8, mean MCH among cases was low compared to that of healthy controls, with mean and standard deviation of 22.6±2.9 and 30.5±2.3 for cases and controls respectively.

Serum ferritin was measured for all study participants. The mean S. Ferritin for all subjects was 139.6±56.9. As the mean S. Ferritin for cases was 85.4±8.5 and that for controls is 193.7±20.5.

All participants with no history of Diabetes mellitus and normal Fasting and Post postprandial blood sugars were recruited for this study. Parameters like Fasting (FBS), Post postprandial blood Sugar (PPBS), and Glycated Haemoglobin (HbA1c) were estimated for all the participants. The mean FBS and PPBS for all the participants were 88.0±7.8 and 124.0±8.5 respectively. The mean FBS among cases and controls were 88.4±0.8 and 87.6±7.8 respectively. There was no significant statistical difference among both the groups when compared using Mann Whitney test (p value=0.72). The mean PPBS among cases were 124.8±8.6 and controls were 123.2±8.6, which was not statistically significant (p-value=0.51).

Glycated Haemoglobin (HbA1c) was estimated for all participants and the mean HbA1c was 6.5±0.6. The mean HbA1c for cases with Iron Deficiency Anaemia was more than that for healthy controls (7.1±0.3 and 6.0±0.3 respectively). There was a significant difference in mean HbA1c when comparing between cases and controls using Mann Whitney test. (P-value<0.0001)

Table 7: Comparison of various parameters between Cases and Controls

Parameters	IDA group (n=25)	Control group (n=25)	Total (n=50)
Hb (g/dl)	8.5±1.6	14.2±0.8	11.3±3.1
HCT, %	30.7±1.6	40.6±4.4	35.6±6.0
MCV, fl	74.4±2.8	89.6±2.9	82.5±8.2
MCH, pg	22.6±2.9	30.5±2.3	26.6±4.8
Ferritin, ng/ml	85.4±8.5	193.7±20.5	139.6±56.9
HbA1c	7.1±0.3	6.0±0.3	6.5±0.6
FBS	88.4±0.8	87.6±7.8	88.0±7.8
PPBS	124.8±8.6	123.2±8.6	124.0±8.5

In our study, we did not find any significant correlation between haemoglobin and HbA1c (r=0.388, P=0.055). When we studied correlation for red cell indices like PCV, MCV, MCH, serum Ferritin, and HbA1c in IDA subjects haematocrit (PCV) and MCH had a significant negative correlation against HbA1c (Pearson correlation coefficient r = -0.527; p-value =0.007 & r = -0.417; P-value 0.038 respectively). No significant correlation was found between HbA1c and MCV (r =-0.306, P=0.137), and HbA1c and ferritin (r- -0.196, P=0.348).

Correlation between HbA1C and haematological parameters

Hba1c and haematological parameters	Pearson correlation	P value
Haemoglobin	-0.388	0.055
PCV	-0.527	0.007
MCH	-0.417	0.038
MCV	-0.306	0.137
S. Ferritin	-0.196	0.348

This is clearly evident that there is a negative correlation between Haemoglobin and HbA1c. With decrease in Haemoglobin values, HbA1c increases. But this negative correlation is not statistically Significant when analysed using Pearson correlation coefficient (r value .0.388, P=0.055).

Discussion

The diagnosis of diabetes was based on plasma glucose criteria, either the fasting plasma glucose (FPG) or the 2-h value in the 75-g oral glucose tolerance test (OGTT) throughout the world, for more than decades. In 2009, an International Expert Committee that included representatives of the American Diabetes Association (ADA), the International Diabetes Federation (IDF)", and the European Association for the Study of Diabetes (EASD) recommended the use of the HbA1c test to diagnose diabetes, with a threshold of 26.5% International Expert Committee and the ADA adopted this criterion in 2010. Also, the diagnostic test should be performed using a method that is certified by the National Glycohemoglobin Standardization Program (NGSP) and standardized or traceable to the Diabetes Control and Complications Trial (DCCT) reference assay.

American Diabetes Association in their Standards of Medical Care in Diabetes 2013; Position statement has given criteria for diagnosing diabetes by using four parameters for diabetes diagnosis;

1) HbA1C value more than or equal to 6.5%.
2) Fasting plasma glucose (FPG) ≥ 126 mg/dL or
3) 2-hour plasma glucose ≥ 200 mg/dL or
4) In a patient with classic symptoms of hyperglycaemia or hyperglycaemic crisis, a random plasma glucose ≥ 200 mg/dL.

It is clearly evident from the previous criteria that, HbA1c value more than or equal to 6.5% is used for diagnosing diabetes. ADA recommends to:

- Perform the HbA1c test at least two times a year (half yearly) inpatients who are meeting treatment goals (and who have stable glycaemic control).
- Perform the HbA1c test at least two times a year (quarterly) inpatients for those whose therapy has changed or who are not meeting glycaemic goals.

Use of POC (Point-of-care) testing for HbA1c provides the opportunity for more timely treatment changes.

In our study, we included a total of 50 patients, of which 25 were in the iron deficiency anaemia group and 25 in the control (normal) group. There is equal distribution in age groups of 20-39 years and 40-59 years of age with 23 (46%) each and remaining 4 (8%) were more than 60 years.

The mean age of the patients was 20.3 years (range = 12-50 years) and the mean age of the control participants was 36.2 years (range = 13-50 years); whereas in our study, the mean age of cases was 40.3±10.7 years and mean age of controls was 38.4±12.9, the mean age of the study population was 38.41±17.6 years and the mean of the control group was 39.17±17.9 years; those who were more than 40 years of age constituted 33% and the rest 67% were up to 40 years of age; whereas, in IDA Group, 21 patients (33%) were in the age group of 31-40 years and constituted the largest group.

Among the study participants of our study, there were 27 (54%) females and 23 (46%) males and there were 15 (60%) females and 10 (40%) males in the cases and 12 (48%) female subjects and 13 (52%) male subjects in the controls.

The sex wise distribution of Cases (IDA) and Control (Healthy) and found that in the case group males were 33.33% while in control group males were 50%.

Complete Hemogram including Haemoglobin (g/dL), Haematocrit (%), Mean corpuscular volume (MCV) (fL), Mean corpuscular Haemoglobin (MCH) (Pg) and Serum Ferritin were estimated for all the cases and controls. Mean Hb among cases was 8.48±1.5 and that among controls was 14.2±0.8. Mean Hb among males in case group was 9.3±1.41 gm/dL and that of healthy controls was 15.7±1.01 gm/dL. Likewise Mean Hb among females in case group was 7.9±1.43 mg/dl and that of healthy controls was 12.6±0.51 gm/dL. These values evidently prove that Hb was lower in anemic patients than in healthy controls, and the observed difference was statistically significant (Chi-square test P<0.001).

Blood haemoglobin (gm/dl) among non-anemic was

12.81±0.66 and that among anemic patients was 9.38±1.74; similar to our study subjects.

The mean haemoglobin levels of patients at baseline and after 1 and 2 months of Iron therapy were 6.2 g/dL, 9.7 g/dL, and 12.5 g/dL, respectively, the mean haemoglobin level of the control group was 13.4 g/dL. These data were in concurrence with our finding and this provided evidence that haemoglobin was indeed lower in anemic patients than in healthy controls. The range of Hb was from 4.1 to 10.5 g/dl.

The average Hb level among males with IDA was 7.59 g/dl and among females with IDA was 6, 54 g/dl whereas the average Hb level among males in the control group was 14.03 g/dl and among females in the control group was 12.47 g/dl; Also the mean Hb in the cases and controls were 6.84±1.63 g/dl and 12.87±1.3 g/dl respectively.

In our study, among cases, 15 (60%) were having moderate anaemia with Hb between 8-10 g/dl, while 9 (36%) were having severe anaemia (Hb < 8g/dL). One patient had mild anaemia with Hb value between (>10-12gm/dL). Among those with severe anaemia, 7 (28%) were females and 2 (8%) were males and in moderate anaemia, 8 (32%) were females and 7 (28%) were males. One male patient (4%) had mild anaemia.

While comparing the Mean haematocrit among cases and controls in our study, we observed that among cases, it was found to be 30.7±1.6 and in controls was 40.6±4.4 whereas total mean haematocrit was found to be 35.6±6.0. Mean Corpuscular Volume (MCV) for cases was low (74.4±2.8) than that for controls (89.6±2.9) with a total mean of 82.0±8.2. With a total mean MCH of 26.6±4.8. Mean MCH among cases was low compared to that of healthy controls, with mean and standard deviation of 22.6±2.9 and 30.5±2.3 for cases and controls respectively.

Serum Ferritin is a storage form of iron, and it reflects the true iron status in human body. In our study, Serum ferritin was measured for all study participants. The mean S. Ferritin for all subjects was 139.6±56.9 whereas the mean S. Ferritin for cases was 85.4±8.5 and 193.7±20.5 for controls.

This explains that in iron deficiency anaemia, ferritin is decreased with increase in the red cell life span, and increased red cell life span is associated with increased HbA1c. Analysis of Hemogram in our study found that, mean Hb was low among the cases compared to the controls Also other bio-chemical parameters like Haematocrit, Mean corpuscular volume (MCV), Mean corpuscular Haemoglobin (MCH) and Serum Ferritin were also low among the cases than the controls.

For assessing the glycaemic profile we have estimated, parameters like Fasting blood sugar (FBS), Post postprandial blood Sugar (PPBS), and Glycated Haemoglobin (HbA1c) for all the participants. Participants with no previous history of Diabetes mellitus and normal Fasting and Post postprandial blood sugars were recruited for this study. In our study, the mean FBS for all participants were 88.0±7.8, for cases was 88±0.8 and that for controls was 87.6±7.8. There was no significant statistical difference among both cases and controls when compared using Mann Whitney test (p value =0.72).

The mean PPBS for all the participants were 124.0±8.5, that among cases were 124.8±8.6 and controls were 123.2±8.6, which was not statistically significant (p-value=0.51).

In our study, Glycated Haemoglobin (HbA1c) was estimated for all participants and the mean HbA1c was 6.5±0.6. The mean HbA1c for cases with Iron Deficiency Anaemia was more than that for healthy controls (7.1±0.3) and 6.0±0.3 respectively). There was a significant difference in mean HbA1c when comparing between cases and controls using Mann Whitney test. (P-value <0.0001).

In contrast to our study findings, estimated baseline mean HbA1c levels in anemic patients were 4.6% and that in the controls was 5.5%. After 2 months of treatment for iron deficiency anaemia, mean HbA1c levels increased by 5.4%, and 5.9 after 1 and 2 months, respectively which was statistically significant (P<0.01). They concluded that, HbA1c levels and absolute HbA1c levels increased with treatment of iron deficiency anaemia.

The linear relationship between Haemoglobin and HbA1c holds true for anaemic and non-anaemic populations. In contrast to other studies, Non-diabetics, anaemics have a significantly lower mean HbA1c (5.3% vs. 5.7%), but a similar upper limit of reference range due to higher variance. Iron deficiency anaemia is one the most common anaemia amongst the nutritional anaemia in India and other in developing countries.

Several studies on effects of iron therapy on Glycated haemoglobin (HbA1c) found a clinically and statistically significant reduction in HbA1c levels after iron therapy in non-diabetic population. Biochemically, haemoglobin glycation is an irreversible process where glucose in the red cells reacts with N-terminal valine of both beta chains to form an aldimine linkage which undergoes re-arrangement forming a more stable keto-amine link. Hence, HbA1c levels in RBC will be increased with cell age. In iron deficiency anaemia, red cell production decreases consequently an increased average age of circulating red cells ultimately leads to elevated HbA1c levels.

In our study, we did not find any significant correlation between haemoglobin and HbA1c (r = -0.388, P=0.055). When we studied correlation for red cell indices like PCV, MCV, MCH, serum Ferritin, and HbA1c in IDA subjects haematocrit (PCV) and MCH had a significant negative correlation against HbA1c (Pearson correlation coefficient r=-0.527: p-value=0.007 & 0.417; p-value=0.038 respectively). No significant correlation was found between HbA1c and MCV (r=0.306, P=0.137) and HbA1c and ferritin=-0.196, P=0.348).

Results of our study suggested that IDA was associated with higher concentrations of HbA1c.

Summary

Study participants were categorized into Cases with IDA and healthy Controls; 25 were in the iron deficiency anaemia group and 25 in the control (normal) group.

In the 20-39 years age group there were about 11 (44%) cases and 12 (48%) controls. In 40-59 years category there were 13 (52%) cases and 10 (40%) controls whereas, in age group > 60 years, there was one (4.0%) case and 3 (12%) controls. The mean age of cases was 40.3 10.7 years and mean age of controls was 38.4±12.9 years.

There were 27 (54%) females and 23 (46 %) males of which 15 (60%) females and 10 (40 %) males in the cases and 12 (48%) female subjects and 13 (52%) male subjects in the controls.

The range of Haemoglobin among study participants is from 5.4 gm/dL to 15.5 gm/dL. Mean Hb among cases was

8.48±1.5 (5.4 to 10.9 gm/dL) and that among controls was 14.2±0.8 (12.3-15.5 gm/dL). Thus Hb, serum ferritin levels (index of iron deficiency status) were low among the cases when compared to the controls. The Hb, Haematocrit, MCV, MCH, serum ferritin and the HbA1c levels were normal in the control group.

The mean HbA1c was 6.5±0.6. The mean HbA1c for cases with Iron Deficiency Anaemia was more than that for healthy controls (7.1±0.3 and 6.0±0.3 respectively) (p-value <0.0001). While comparing among cases and controls, the serum HbA1c levels were significantly increased among the IDA patients as compared to those in the controls. With decrease in Haemoglobin values, HbA1c increases. There was no significant correlation between Haemoglobin and HbA1c (Pearson correlation coefficient r 0.388, P=0.055).

Haematocrit (PCV) and HbA1c (Pearson correlation coefficient r =0.527; p-value 0.007) and MCH and HbA1c had a significant negative correlation (r= -0.417; p-value =0.038). No significant correlation was found between HbA1c and MCV (r=.0.306, P=0.137), and HbA1c and ferritin (r =-0.196, P 0.348).

Conclusion

HbA1c is not affected by the blood sugar levels alone. There are certain confounding factors when HbA1c is measured, especially that of iron deficiency, which is the commonest of the nutritional deficiency diseases in India. Our study concludes that iron deficiency was associated with higher proportions of HbA1c, which could cause problems in the diagnostic and therapeutic interpretation of the HbA1c concentrations. Hence, the iron status must be considered during the interpretation of the HbA1c concentrations in Diabetes mellitus. In diabetic patients with iron deficiency, iron replacement therapy would also increase the reliability of the HbA1c determinations.

References

1. Gonen B, Robenstein AH, Rochman H, Tanega SP, Horwitz DL. Haemoglobin A1C: an indicator of the metabolic control of diabetic patients. Lancet. 1977; 2:734-6.
2. Koenig RJ, Peterson CM, Jones RL, Saudek C, Lehrman M, Cerami A. Correlation of glucose regulation and hemoglobin Ale in diabetes mellitus. N Engl J Med. 1976; 295:417-20.
3. Rajni Dawar Mahajana, Bhawesh Mishra. Using Glycated Hemoglobin Hb Alc for diagnosis of Diabetes mellitus: An Indian perspective. Int J Biol Med Res. 2011: 2:508-512.
4. ADA. American Diabetes Association. Position statement: Standards of Medical Care in Diabetes. Diabetes Care. 2013; 36(1):S11-66
5. Stetler C, Mueller B, Diem P. What you always wanted to know about Hb Alc. Schweiz Med Wochenschr. 2000; 130:993-1005.
6. Hardikar PS, Joshi SM, Bhat DS *et al*. Spuriously high prevalence of prediabetes diagnosed by Hb Alc in young Indians partly explained by hematological factors and iron deficiency anemia. Diabetes Care. 2012; 35:797-802.
7. Nitin Sinha, Mishra TK, Tejinder Singh, Naresh Gupta. Effect of Iron Deficiency Anemia on Hemoglobin Alc Levels. Ann Lab Med. 2012; 32:17-22.
8. Parlapally RP, Kumari KR, Srujana T. Effect of Iron Deficiency Anemia on Glycation of Hemoglobin in Non Diabetics. Int J Sci Stud. 2016; 4(5):192-196.
9. Coban E, Ozdogan M, Timuragaoglu A. The effect of iron deficiency anemia on the levels of haemoglobin Alc in non-diabetic patients Acta Haematol. 2004; 1(12):126-28.