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# The effects of microcytic hypochromic anemia on HBA1C in non-diabetics

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**Abstract**
**Background:** *Hemoglobin A1c reflects patient's glycemic status over previous 3 months. Iron deficiency anemia elevates hbA1c concentration independent of glycemia. This study aim to analyze effect of microcytic hypochromic anemia on HB1C in non-diabetic.*
**Inclusion Criteria**
*Males and females,18 – 60 year age group, Microcytic and hypochromic anemic patients, Non diabetics.*
**Exclusion Criteria**
*Below 18 years and above 60 years, Known diabetics, Anemia other than microcytic hypochromic, Patients with heamoglobinpathies and haemolytic anemia, History of acute or chronic blood loss, Acute renal failure & chronic renal failure patients, Pregnant females, History of chronic alcoholism.*
**Aims & Objectives:** *The study aimed to find the co relation between microcytic hypochromic anemia and glycosylated hemoglobin and to exercise caution while using HbA1C levels to diagnose diabetes in patients who have microcytic hypochromic anemia.*
**Material & Methods:** *The study was conducted at MGM Hospital Kamothe over a period of two years with 50 patients and 50 control group which include all non-anemic, non-diabetic individuals. HbA1c was compared in the anaemic group vs. non-anaemic control group*
**Results:** *The study established that HbA1c was significantly raised in anemic individuals, hence it is imperative to watch for anemia or to avoid using HbA1c altogether as a diagnostic or prognostic test for diabetes in anemic patients. The study establishes HbA1c is raised in individuals with microcytic hypochromic anemia. In anemic individuals novels markers like glycated albumin and frcutosamine may be used as an alternative to HbA1c.*
**Keywords:** *Microcytic Hypochromic anemia, glycosylated hemoglobin.*

## Introduction

The gold Standard for monitoring glycaemic control and for prediction of diabetic complications is glycosylated haemoglobin.[1] HbA1c has been recommended by The ADA (American Diabetic Association) and the ACE (American College of Endocrinology) as one of the criteria for diagnosis of diabetes mellitus. Kim et al (2010) stated that microcytic hypochromic anaemia & more specifically iron deficiency is associated with shifts in HbA1c distribution from <5.0 to ≥ 5.5%[2] and on treating the anaemia significant decrease was observed in the patients' absolute HbA1c levels.[3] Some studies show that in microcytic hypochromic anaemia the HbA1c levels are falsely increased and this is attributed to

both modifications in the structure of haemoglobin and levels of HbA1c in old and new red blood cells.[4,5] In the light of the uncertainty in the influence of anaemia and haemoglobinopathies on HbA1c, it is imperative that clinicians are aware of the caveats with HbA1c values when they make management decisions regarding diagnosing and modification in treatment of diabetes mellitus in the anaemic population[6] and hence the researcher was prompted to study the effects of microcytic hypochromic anaemia on HbA1c levels in Indian non-diabetic adults.

**Aims & Objectives**

- ✓ To study the co relation between microcytic hypochromic anemia and glycosylated hemoglobin.
- ✓ To exercise caution while using HbA1C levels to diagnose diabetes in patients who have microcytic hypochromic anemia.

**Materials & Methods**

The study was conducted at MGM Hospital Kamothe over a period of two years with a target of minimum 50 patients and 50 control group which include all non-anemic, non-diabetic individuals.

**Inclusion criteria**

- ✓ Males and females, 18 – 60 year age group, Microcytic and hypochromic anemic patients, Non diabetics.

**Exclusion criteria**

- ✓ Below 18 years and above 60 years, Known diabetics, Anemia other than microcytic hypochromic, Patients with heamoglobinpathies and haemolytic anemia, History of acute or chronic blood loss, Acute renal failure & chronic renal failure patients, Pregnant females, History of chronic alcoholism.

A detail general and physical examination was done to look for signs of anaemia like pallor, nail changes, hair changes like thinning and early greying and hemic murmurs. The patients were then subjected to minimal set of blood tests after written informed consent.

**Observation & Results**

**Case study group**

It was observed that the mean hemoglobin value in the age group 25 and less was 8.04 g/dl, and 6.67 g/dl for the age group of 26 to 35 years. It was 7.60 g/dl between ages 36 to 45 years. No hemoglobin trend could be established with age. The mean HbA1c was 5.75% in individuals 25 years and under. Between 26 to 35 years it was 6.0%. Between 36 to 45 years the mean HbA1c was 5.90%. Between 46 to 55 years mean HbA1c was 6.0 %. In individuals 55 years and above the mean HbA1c was 5.94%.

**Control group**

In the control group, it was observed that the hemoglobin value in the age group 25 years and less was 14.61 g/dl, and 13.89 g/dl for the age group of 26 to 35 years. For the age group 36 to 45 years the mean hemoglobin was 13.84 g/dl. Between 46 to 55 years the mean hemoglobin was 13.60 g/dl. 55 years and above the mean hemoglobin was 13.06 g/dl. The mean HbA1c in 25 years and less was 4.68%. Between 26 to 35 years it was 4.74%. Between 36 to 45 years the mean HbA1c was 4.72%. Between 46 to 55 years the mean HbA1c was 4.57%. Above 55 years mean HbA1c was 4.79%.

To summarize the hemoglobin was reduced in all age groups of the case group as compared to control group and the HbA1c is raised in all age groups in the case group as compared to the control group.

The analysis showed that the minimum value of Hemoglobin in case group was 2.7g/dl and maximum was 11.2g/dl with average hemoglobin being 7.862 g/dl. In control group the minimum hemoglobin value was 12.1 g/dl and maximum was 16.9 g/dl with average hemoglobin of 13.834 g/dl. In case group minimum MCV value was 51.3 fl, while maximum MCV was 94.7fl with average MCV being 72.063 fl. The minimum MCV was 69.4 fl, while maximum being 99.5 fl

with an average MCV of 85.191 fl. The minimum HbA1c in the anemic group was 5.3% while maximum HbA1c was 6.4% with average HbA1c was 5.938%. The minimum HbA1c in control group was 4% and maximum HbA1c was 5.2% with a mean HbA1c was 4.696%. Comparing HbA1c between anemic and non-anemic group (case v/s control group) the HbA1c in anemic group was significantly higher than non-anemic group.

T-test results of the Case and control comparison

| | Hb | MCV | HbA1C |
|---|---|---|---|
| Difference | -5.972 | -13.1281 | 1.242 |
| t (Observed vaue) | -17.640 | -8.089 | 24.695 |
| \|t\| (Critical value) | 1.984 | 1.985251 | 1.984 |
| d.f. | 98 | 95 | 98 |
| p-value (Two-tailed) | < 0.0001 | < 0.0001 | < 0.0001 |

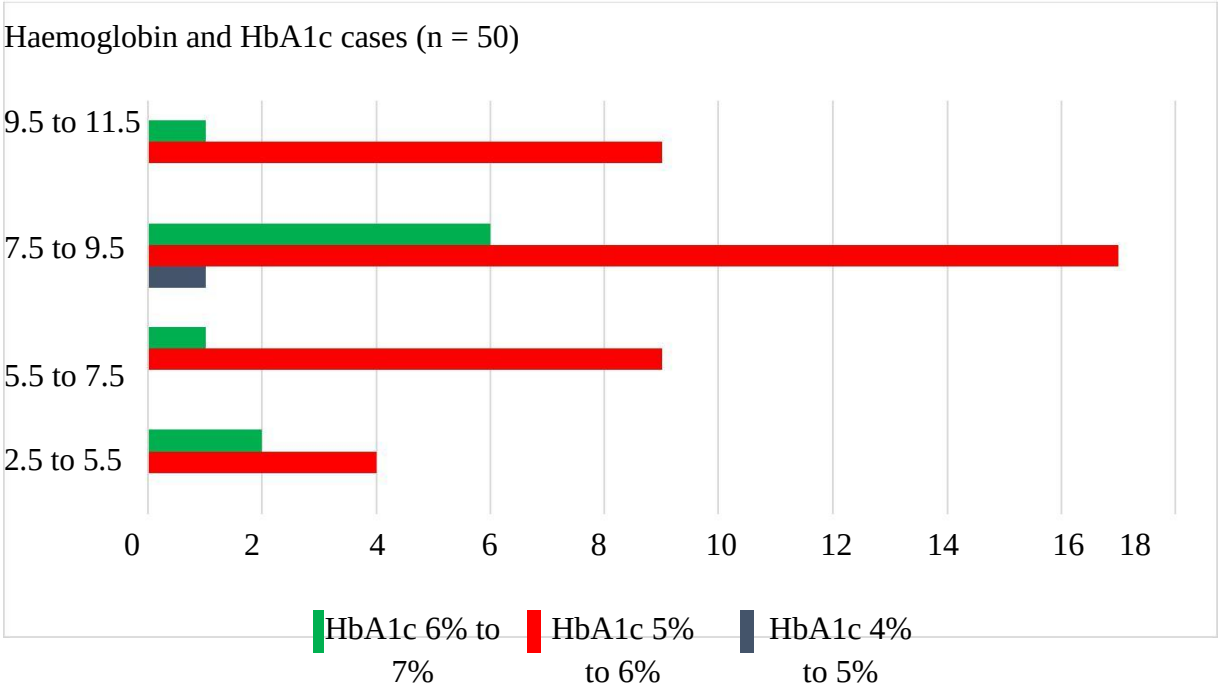
Since p-value for the independent t-test is less than that of 0.05 indicates significance of difference between the means of Hemoglobin in case group and control group. The Hemoglobin of control group was significantly more than that of case group.

Since p-value for the independent t-test was less than that of 0.05 indicates significance of difference between the means of MCV in case group and control group. The MCV of control group was significantly more than that of case group.

Since p-value for the independent t-test is less than that of 0.05 indicates significance of difference between the means of HbA1C in case group and control group.

This confirms our findings of HbA1c being significantly more in anemic group as compared to HbA1c in non-anemic (control) group

**Correlation between HbA1C and haemoglobin in case study group**




As shown in graph in the case group 78% individuals had HbA1c between 5% to 6%. Out of these, 70.8% fell in the hemoglobin category of 7.5 g/dl to 9.5 g/dl.

20% individuals had HbA1c between 6% to 7% and out of these, 25% had hemoglobin between 7.5 to 9.5 g/dl.

Only 1 individual had HbA1c between 4 to 5%, indicating that HbA1c is persistently raised in anaemic individuals.

**Case Group**

**Correlation between degree of anemia and HbA1c in case group**

| Correlation Values (n=100) | | |
|---|---|---|
| Variables | **MCV** | **Hba1c** |
| Hb | 0.219 | -0.130 |
| MCV | | 0.005 |
| Hba1c | | |
| **P-Values** | | |
| Variables | **MCV** | **Hba1c** |
| Hb | 0.127 | 0.369 |
| MCV | | 0.973 |

In the case (anemic) group it was attempted to correlate the level of hemoglobin with HbA1c. The correlation coefficient value of -0.130 indicates very weak negative correlation between hemoglobin and HbA1C, i.e the HbA1c levels increase with a dropping hemoglobin, but the p-value 0.369 > 0.05 indicates statistically no significant correlation. Hence there is no such formula to predict the equation between drop of hemoglobin with increase in HbA1c or vice versa. It was also attempted to correlate the MCV with HbA1c levels but a correlation coefficient value of 0.005 with p-value 0.973 > 0.05 indicates no correlation can be established.

**Results for control group**

**Correlation between degree of anemia and HbA1c in control group**

| Correlation Values (n=50) | | |
|---|---|---|
| Variables | **MCV** | **Hba1c** |
| Hb | 0.192 | 0.134 |
| MCV | | -0.141 |
| Hba1c | | |
| P-Values | | |
| Variables | **MCV** | **Hba1c** |
| Hb | 0.197 | 0.354 |
| MCV | | 0.345 |

As shown in table above the hemoglobin and HbA1c in control group had a coefficient value of 0.134 indicates no correlation between the two variables. The correlation between MCV and HbA1c in control group showed a coefficient value of -0.141 indicates very weak negative correlation between MCV and HbA1C, i.e with the rise in MCV the hbA1c was reducing. But the p-value 0.345 > 0.05 indicates statistically no significant correlation.

**Discussion**

Diabetes mellitus is a metabolic disease which is caused by insulin deficiency which may be relative or absolute. Studies have shown that 10% of the Indian population suffers from diabetes mellitus.[7] HbA1c has now become the cornerstone in diagnosis of diabetes. HbA1c is majorly affected by the blood glucose levels but, HbA1c levels are also altered by various other coexisting factors, especially anemia, which is a major public health problem in a developing country like India. In the case study group maximum number of individuals belonged to the age group of 26 years to 35 years followed by individuals above 55 years. Most individuals in the case group were females indicating higher incidences of anemia in the female sex. In the case study group minimum hemoglobin was 2.7 g/dl while the maximum hemoglobin was 11.2 g/dl having mean hemoglobin of 7.86 g/dl. In the control group the minimum hemoglobin value as 12.1 g/dl and maximum as 16.9 g/dl with average hemoglobin of 13.834 g/dl. The mean hemoglobin in the case study group was significantly lower. The mean MCV values were 72.6 fl and 85.19 fl in case and control group respectively. The mean HbA1c in the case group was 5.93% and 4.69% in control group. This showed raised HbA1c levels in case group and this was confirmed by the p-value <0.05 which showed statistical significance of the raised HbA1c. The findings of the study confirmed an elevated HbA1c levels in individuals with microcytic hypochromic anemia. On comparing data and applying statistical tests it is found that it is not possible to predict HbA1c at a particular hemoglobin level. The same was not possible for MCV and HbA1c. In the case study group the mean HbA1c was 5.75% in the age group of 25 years and less. It was 6.0% in 26 years to 35 years and 46 years to 55 years age group. In individuals above 55 years mean HbA1c was 5.94%. The mean HbA1c in 25 years and less was 4.68%. Between 26 to 35 years it was 4.74%. Between 36 to 45 years the mean HbA1c was 4.72%. Between 46 to 55 years the mean HbA1c

was 4.57%. Above 55 years mean HbA1c was 4.79%.

In the anemic group the HbA1c is spuriously high irrespective of age, but in the control group the HbA1c levels show a mild upward trend with increasing age. In the study the mean HbA1c was 5.93%, 92% of the individuals in the case group had HbA1c above 5.7%, which is the cut off for prediabetes. As per this study the inclusion and exclusion criteria all subjects in the case group were non diabetics having a normal fasting blood glucose and normal post prandial blood glucose.

**Conclusion**

The study established that HbA1c was significantly raised in anemic individuals, hence it is imperative to watch for anemia or to avoid using HbA1c altogether as a diagnostic or prognostic test for diabetes in anemic patients. Newer markers like glycated albumin and frcutosamine should be used which are more sensitive and are not affected by multiple systemic illnesses. In the study no correlation could be established between the degree of anemia and the expected rise in HbA1c. The study establishes HbA1c is raised in individuals with microcytic hypochromic anemia. This is in concordance with similar studies in the past. Keeping this in mind it is necessary to look for other confounding factors which affect HbA1c when using HbA1c for diagnosis and prognosis of diabetes. In anemic individuals who are also diabetic HbA1c will not be an appropriate marker to assess the blood sugar control and to predict diabetic complications. In anemic individuals novels markers like glycated albumin and frcutosamine may be used as an alternative to HbA1c.

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