

Correlation of Glycated Hemoglobin with Plasma Glucose in Type 2 Diabetes Patients

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Abstract:

Background: Diabetes is emerging as a common disease in both developed and developing countries. Increasing prevalence of the disease sets the goal to aim for control of the disease process which is aimed mainly as therapy. Monitoring tool for the complications of this common disease is Glycated Hemoglobin (HbA1C). In the present retrospective study HbA1C level is correlated with both fasting and post meal plasma glucose level in type-2 diabetes mellitus patients.

Materials and Methods:Data were collected from Computerized Hospital Information Processing System (CHIPS) department on the basis of HbA1c tests ordered during October, 2014. Data collected from the Computerized Hospital Information Processing System (CHIPS) data base consisted of patient's hospital number, name, age, sex, test results for HbA1C, fasting and post-prandial plasma glucose levels and the final diagnosis of the patient. Correlation study was done to find correlation between HbA1C and plasma glucose levels (fasting and post prandial plasma glucose).

Results:Both fasting and postprandial plasma glucose showed significant correlation with HbA1C ($r=0.631$; $p=0.000$ vs $r=0.590$; $p=0.000$). Therapeutic target to lower both fasting and two-hour plasma glucose during oral glucose tolerance test glucose while treating patients with type 2 diabetes mellitus, so as to reduce long term risks associated with the disease process.

Keywords: Glycated Hemoglobin (HbA1C), fasting plasma glucose, post prandial plasma glucose

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I. Introduction

Diabetes mellitus is a group of metabolic disorders characterized by hyperglycemia resulting from either defect in insulin secretion, insulin at its sites of action, or both (1). Diabetes is a common disease but the exact prevalence is unknown. The number of people with diabetes has increased dramatically worldwide. It was estimated by the year 2035, this number is predicted to reach 592 million and 80% of this population will live in low- and middle-income countries (3) (5). In the United States, the prevalence from 1999 to 2002 was 9.3%, 30% of whom were undiagnosed. Analysis of the 2005–2006 National Health and Nutritional Examination Survey (NHANES) using both fasting glucose and oral glucose tolerance testing (OGTT) shows a prevalence of diabetes in the United States in persons 20 years of age and older of 12.9% (equivalent to ≈ 40 million people) (2). Similarly, the prevalence of diabetes in Asian populations has increased rapidly in recent decades, with China and India ranked first and second, respectively, among countries with the largest diabetic populations (4). Recent analysis in Chinese adults suggests that in 2010 the estimated prevalence of diabetes and prediabetes was 11.6% and 50.1%, respectively. Acute and chronic complications make diabetes the fourth most common cause of death in the developed world (1).

Glycated hemoglobin (HbA1c) is formed non-enzymatically by condensation of glucose or other reducing sugars with beta-globin chains of hemoglobin. HbA1c is used to diagnose diabetes, monitor glycemic control, evaluate the need to change therapy, and predict the development of micro vascular complications (1). Diabetes mellitus was diagnosed based on the guidelines (American Diabetic Association) as follows

Any one of the following is diagnostic for diabetes mellitus:

1. Hemoglobin A1c (HbA1c) 6.5% or greater, OR
2. Fasting plasma glucose (FPG) 126 mg/dL or greater, OR
3. Symptoms of hyperglycemia and casual plasma glucose 200 mg/dL or greater, OR
4. Two-hour plasma glucose 200 mg/dL or greater during an oral glucose tolerance test (OGTT)

In the absence of unequivocal hyperglycemia, these criteria should be confirmed by repeating the same test on a different day (2). Mixing different methods to diagnose diabetes should be avoided (2).

Blood levels of HbA1c have been used for monitoring the degree of control of glucose levels in diabetic patients since 1976. A total of 30-35% of reduction in micro vascular complications occurs per 1% absolute reduction in

glycated hemoglobin (Hb). It is found that a 14 to 16% decrease in macro vascular complication occurs for every 1% absolute reductions in glycated Hb (5). It was introduced as a routine test in the Department of Clinical Biochemistry, Christian Medical College, Vellore, in 1995 for monitoring extent of control blood glucose levels in diabetic patients. Fasting or post prandial plasma glucose level alone or in combination will be necessary in adjusting the therapy to achieve optimal HbA1C levels in type-2 diabetes mellitus.

II. Aim Of The Study

In the present retrospective study HbA1C level is correlated with both fasting and post meal plasma glucose level in type-2 diabetes mellitus patients. It can be an alternative economical test, compared to HbA1C for glycemic control for uncomplicated diabetic patients.

III. Materials And Methods

The retrospective study was done in Christian Medical College, Vellore from the data were collected from Computerized Hospital Information Processing System (CHIPS) department on the basis of HbA1c tests ordered during October, 2014.

Study design: Retrospective study

Study Location: Christian Medical College, Vellore was a tertiary care teaching hospital based study done in the department of Biochemistry.

Study duration: Data collected from Computerized Hospital Information Processing System (CHIPS) on the basis of HbA1C test ordered by various departments of Christian Medical College, Vellore, October 1st and 30th 2014 (both days included).

Subject and selection method: Data collected from the Computerized Hospital Information Processing System (CHIPS) data base consisted of patient's hospital number, name, age, sex, test results for HbA1c, fasting and post-prandial plasma glucose levels and the final diagnosis of the patient. It was ascertained whether this occasion was a patient's first visit to Christian Medical College, Vellore or whether they had been seen in Christian Medical College, Vellore earlier. This was done by checking to see whether the patients had previous records of laboratory tests done. For patients on their first visit, their values for HbA1c were used to designate them into those who had normal levels ($\leq 5.6\%$), those who were pre-diabetic (5.7-6.4%) and those who were diabetic ($\geq 6.5\%$). For these new patients, it was assumed that the HbA1c test was done as a diagnostic test for diabetes mellitus and diabetic patients were included in the study. Other patients were selected based on the diagnosis given by the Computerized Hospital Information Processing System (CHIPS).

Statistical analysis: Data was analyzed using SPSS (Statistical Package for Social Sciences) version 21.0, using appropriate tests. A p value of less than 0.05 was taken to indicate statistical significance

IV. Results

Data collected from Computerized Hospital Information Processing System (CHIPS) department on the basis of HbA1c tests ordered during October, 2014. It was found that for 8663 patients HbA1c was ordered. The test was ordered for 3750 female patients (43.3% of the total patients) and 4913 male patients (56.7% of the total patients). 1973 (22.78%) tests were ordered from broad specialty departments (Emergency Medicine, Community Medicine, Child Health, Dermatology, Dental, ENT, Family Medicine, General Medicine, Geriatric Medicine, Obstetrics and Gynaecology, Orthopaedics, Reproductive Medicine, Respiratory Medicine and Staff Student Health Service) 6690 (77.22%) tests were ordered from super specialty (Cardiology, Endocrinology, Paediatric Endocrinology, Endocrine Surgery, Gastroenterology, Hepato-biliary Surgery, Haematology, Medical Genetics, Medical Oncology, Nephrology, Neurology, Paediatric Orthopaedics, Rheumatology, Thoracic Surgery, Urology and Vascular Surgery) (Table -1).

Table 1: Percentage distribution of patient data

	Number	Percentage
HbA1c ordered during October, 2014	8663	100%
Number of female patients	3750	43.3%
Number of male patients	4913	56.7%
Tests ordered from broad specialty departments	1973	22.78%
Tests ordered from super specialty departments	6690	77.22%
Patients with diabetes mellitus (Newly diagnosed and known diabetes mellitus patients)	648	7.5%

Out of 8663 patients for whom HbA1c was ordered, 648 patients were diabetic patients who were newly diagnosed as mentioned in materials and methods also known diabetic patients on treatment (Figure-1).

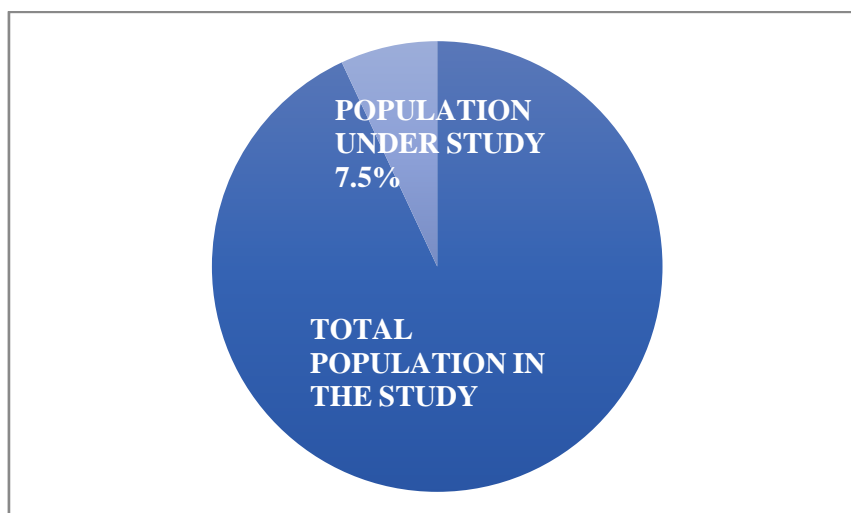


FIGURE-1

648 patients include both the patients from out-patient (416 patients) and in-patient department (232 patients) (Fig 2). Fasting plasma glucose test was available for 218 patients and post prandial plasma glucose was available for 216 patients (Table-2).

Table 2: Percentage distribution of study population

	Number	Percentage
HbA1c ordered during October,2014 in diabetic patients	648	100%
Number of female patients	241	37.2%
Number of male patients	407	62.8%
Number of Fasting plasma glucose test ordered	218	33.6%
Number of post prandial plasma glucose test ordered	216	33.3%

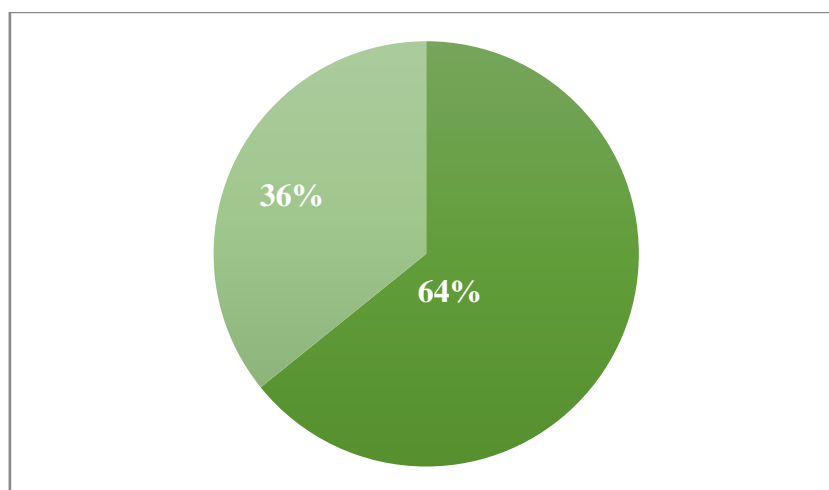


FIGURE-2

Table 3: Descriptive statistics of the study population

	Range	Minimum	Maximum	Median	Skewness
Age	90	0	90	55	-0.699
HbA1c	15.3	4.3	19.6	7.50	1.294
Fasting plasma glucose	372	69	441	138.50	1.383
Post prandial plasma glucose	420	83	503	222.50	0.683

Correlation test showed both fasting and post prandial plasma glucose showed significant correlation with glycated hemoglobin ($r=0.631$; $p=0.000$ vs $r=0.590$; $p=0.000$) (Table 4, Figure 4, 5). Bonora et al, 2001 (9), showed HbA1c correlated more closely to pre-prandial than postprandial blood sugar. Similar conclusions has been reached by Peter et al, 2006 (10) and Goudswaard et al, 2004 (11).

Table 4: Correlation of HbA1c with fasting and post prandial plasma glucose

	Spearman's rho correlation coefficient	p-value
HbA1c (N=648) vs Fasting plasma glucose (N=218)	0.631**	0.000
HbA1c (N=648) vs post prandial plasma glucose (N=216)	0.590**	0.000

**-. Correlation is significant at the 0.01 level (2-tailed).

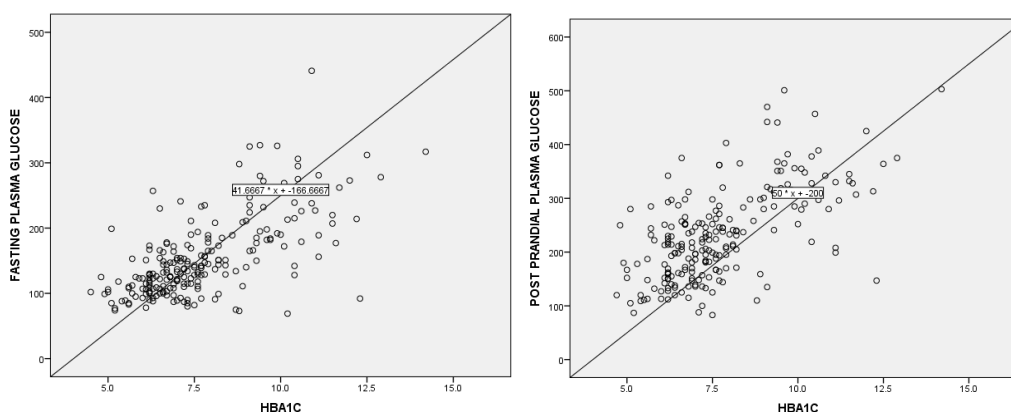


FIGURE 4 **FIGURE 5**

V. Discussion

HbA1C being a diagnostic as well as monitoring tool in diabetes mellitus. The availability and cost of the test makes it difficult for catering the primary health care services. 1% absolute reduction in glycated hemoglobin (Hb) gives 30-35% of reduction in micro vascular complications and 14 to 16% decrease in macro vascular complication (5). The present study aimed to find the correlation between HbA1C and plasma glucose levels (both fasting and post prandial plasma glucose). It was found both fasting and post prandial plasma glucose showed significant correlation with glycated hemoglobin ($r=0.631$; $p=0.000$ vs $r=0.590$; $p=0.000$).

Though definitive correlation can be made out with the data studied, the main limitation of the study is analysis done based on the data, which did not have HbA1C along fasting and postprandial plasma glucose values for same patient. Now as per recent guidelines (American Diabetic Association) two-hour plasma glucose during an oral glucose tolerance test (OGTT) despite of postprandial plasma glucose is considered for diagnosis which was not studied in the present study.

VI. Conclusion

The results suggested that HbA1C significantly correlated with both fasting plasma glucose and postprandial plasma glucose. Therapeutic target to lower both fasting and two-hour plasma glucose during oral glucose tolerance test glucose while treating patients with type 2 diabetes mellitus, so as to reduce long term risks associated with the disease process.

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