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*Original Article*

# CORRELATION BETWEEN FASTING BLOOD GLUCOSE, POSTPRANDIAL BLOOD GLUCOSE AND GLYCATED HEMOGLOBIN IN NON-INSULIN TREATED TYPE 2 DIABETIC SUBJECTS

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**ABSTRACT**

**Background:** Diabetes mellitus (DM) comprises a group of common metabolic disorders that share phenotype of hyperglycemia. **Objectives:** This study was conducted to determine the correlation between glucose monitoring by fasting blood glucose or two hours postprandial blood glucose with glycated hemoglobin (HbA1c) in type 2 diabetic patients. **Method:** A cross sectional study was conducted over a period of six month in the Department of Biochemistry. Institute of Medical, Tribhuvan University Teaching Hospital. Sixty inpatients with Diabetes mellitus type 2 were assessed for daily fasting and postprandial blood sugar for 15 consecutive days. HbA1c was measured on the 15th day. **Result:** Both postprandial blood glucose and fasting blood glucose significantly correlated with HbA1c. Postprandial blood glucose showed better correlation to HbA1c than fasting blood glucose ($r = 0.630$, $P < 0.001$ vs. $r = 0.452$, $P = 0.05$). **Conclusion:** These results show that postprandial blood glucose correlated better than fasting blood glucose to HbA1c. Thus, postprandial blood glucose predicted overall glycemic control better than fasting blood glucose. This finding has potential implications for treatment and monitoring of metabolic control in type-2 diabetes.

**Key Words:** Fasting, Glucose, Glycated hemoglobin, Postprandial

## INTRODUCTION

Diabetes mellitus (DM) comprises a group of common metabolic disorders that share phenotype of hyperglycemia, and is often accompanied by presence of glucose in urine, from which the name of condition is derived.[1,2] $HbA^{1c}$, a form of glycated hemoglobin, is one of the tools, used primarily to assess control of blood glucose over prolonged period of time in diabetic patients, especially with DM type 2.[3] It accounts for about 3-6% of total hemoglobin(Hb).[4] Level of glycated hemoglobin (Hb) depends upon lifespan of Red blood cell (average 120 days) and the blood glucose concentration. It is the best single way for evaluating risk for glycemic damage to tissues including nerves and small blood vessels in eyes and kidneys. Improving $HbA^{1c}$ measurement decreases development and progression of eye, kidney and nerve complication in both DM type 1 and DM type 2. 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] However, $HbA^{1c}$ is not used for diagnosis as it is not sufficiently sensitive.[6] The objective of this study was to find correlation between fasting blood glucose, postprandial blood glucose and $HbA^{1c}$.

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## MATERIALS AND METHODS

A cross-sectional study was conducted at the Department of Biochemistry, Tribhuvan University Teaching Hospital (TUTH), Kathmandu, Nepal, over a period of six months from February 2011 to July 2011. All patients with DM type 2 admitted as inpatients to the medical wards of TUTH were included. The inclusion criteria for subjects were no diabetes diagnosis within previous six months, no change in diabetes treatment in the first day of their stay in the hospital, no insulin treatment before admission or the first day after admission, no changes in diet, treatment, or lifestyle within the three months before the admission and no concomitant chronic diseases or recent acute illness. The exclusion criteria for subjects were individuals with type 1 diabetes mellitus, diabetes diagnosis within previous six months, change in diabetes treatment in the first day of their stay in the hospital, insulin treatment before admission or the first day after admission, changes in diet, treatment, or lifestyle within the three months before the admission and concomitant chronic diseases or recent acute illness.

Blood glucose was measured in fasting condition (6:00-6:30 A.M.) and in postprandial condition (10:00-10:30 A.M.) for 15 consecutive days by Glucore Oxidase Perovidare (GOD-POD) method (Human,Germany) and at the end of 15 days, HbA1c (Axis-Shield, Norway) was assessed by boronate affinity assay.

All data were analysed using Statistical Package for Social Science (SPSS) version 11.5 for windows. For measuring the correlation between two variables, Karl Pearson's coefficient of correlation (r) was calculated.

## RESULTS

A total of 60 patients were enrolled in this study, of which 28 were male and 32 were female. The mean age was 58.9±11.5 years and the duration of diabetes averaged 8±6.8 years.

Plasma glucose averaged 7.83±2.22mmol/l in the fasting state and most subjects had blood glucose level >6.7mmol/l (Table 1). Postprandial average plasma glucose was 14.08±4.13mmol/l and most subjects had blood glucose level >11.1mmol/l in postprandial state (Table 2).

**Table 1: Distribution of diabetic patients by fasting glucose levels**

| Fasting Glucose level | Number | Percentage (%) |
|---|---|---|
| Normal (<6.7 mmol/l) | 14 | 23.3 |
| High (>6.7 mmol/l) | 46 | 76.7 |

Mean ±S.D =7.83 ± 2.22, Range 3.5 – 13.5

**Table 2: Distribution of diabetic patients by postprandial glucose levels**

| Postprandial Glucose level (mmol/L) | Number (N=60) | Percentage (%) |
|---|---|---|
| Normal (<11.1 mmol/L) | 16 | 26.66 |
| High (>11.2 mmol/L) | 44 | 73.33 |

Mean ±S.D = 14.08 ± 4.12, Range 7.00 – 22.5

HbA1c averaged 7.19±1.72. 46.7% of patients had values d" 6.5 % and 53.3% had values >6.5%. Among the former 64% had blood glucose levels >11.1 mmol /l in postprandial state (Table 3).

**Table 3: Distribution of diabetic patients by HbA1c levels**

| HbA1c level | Number | Percentage (%) |
|---|---|---|
| Normal (<6.5%) | 28 | 46.7 |
| High (>6.5%) | 32 | 53.3 |

Mean ±S.D = 7.19±1.72, Range 4.5 – 12.10

Both Postprandial and fasting blood glucose significantly correlated with HbA1c. Postprandial glucose showed better correlation to HbA1c than fasting blood glucose (r= 0.630, p=0.05 vs.r =0.452,p=<0.001) (Table 4).

**Table 4: Correlation between Fasting blood glucose, postprandial blood glucose level and HbA1c)**

| | Coefficient of correlation (r) | P value |
|---|---|---|
| HbA1c vs. Postprandial | 0.630 | < 0.001 |
| HbA1c Vs Fasting | 0.452 | 0.05 |

Spearman's correlation

## DISCUSSION

The main results of the present study are that both FBG and PPBG correlated significantly with HbA1c values. PPBG correlated more strongly with HbA1c in comparison with FBG. This result is in accordance with conclusion reached by Rosediani et al, 2006 that found that PPBG correlated better to HbA1c than FBG.[7] This result is also consistent with various other studies that have found in their studies that postprandial and post challenge glucose levels correlate better with HbA1c values than fasting blood glucose. [8-11]

On the other hand, a study by Bonora et al, 2001, has stated that HbA1c correlated more closely to pre-prandial than postprandial blood sugar.[12] Similar conclusions has been reached by Peter et al, 2006 and Goudswaard et al, 2004.[13, 14]

These findings have strong potential implication in treatment of DM-2. As it is well known fact that reducing HbA1c values can lower risks associated with DM-2, e.g. retinopathy, neuropathy, cardiovascular risks etc, knowing whether FBG or PPBG is independent predictor of HbA1c, aids in choosing effective medication in lowering HbA1c value, i.e., targeting PPBG or FBG to lower HbA1c.

Feinglos et al, 1997, in a study of patients with type 2 diabetes with secondary failure of sulfonylurea therapy, showed that improvement of postprandial hyperglycemia, using insulin lispro (Humalog) at mealtime in combination with a sulfonylurea, not only reduced two hours postprandial glucose excursions, but also reduced both fasting glucose and HbA1c levels from 9.0% to 7.1% ($P<0.001$).[15] Subjects in the lispro group also benefited from significantly decreased total cholesterol levels and improved HDL cholesterol concentrations.

Improvements in HbA1C levels were also reported in a study by Bastyr et al, 2000, which showed that therapy focused on lowering postprandial glucose versus fasting glucose may be better for lowering glycated hemoglobin levels.[16] Further, De Veciana et al, 1995, in his study of patients with gestational diabetes demonstrated that targeting treatment to one hour postprandial glucose levels rather than fasting glucose reduces glycated hemoglobin levels and improves neonatal outcomes.[17]

Bonora et al, 2001, also found that there is lack of strong correlation between HbA1c and glucose levels in a single day.[12] This is indirect proof that the blood glucose profile varies day by day, although more informative than a sporadic fasting or random glucose determination, cannot adequately describe daily glucose profiles occurring within several weeks period. Indeed Brewer et al, 1998, has concluded that several glucose determinations over a period of several weeks are better correlated to HbA1c than a single or a few glucose determinations on a single day.[18]

This study, which includes FBG and PPBG values of 15 consecutive days, may give more consistent conclusion. Another reason for 15 consecutive day glucose monitoring was that, several new studies have concluded the fact that HbA1c actually is a weighted average rather than a simple average. Contrasting the well accepted view that HbA1c represents average glycation process of two to three months, these studies have found that it represents glycation process of recent four weeks, and again, values are heavily weighted to recent two weeks and are almost insensitive to changes occurring in more than one month. They have attributed this fact to the reversible reaction, which formerly was believed to be irreversible.[19]

One of the limitations of the study was that it was conducted on hospital visiting patients only. Besides, larger sample size should be taken.

## CONCLUSION

The results suggest that both fasting blood glucose and postprandial blood glucose correlated significantly with HbA1c. Postprandial blood glucose show better correlation with HbA1c than does fasting blood glucose. This study highlights necessity of having a clear idea of targeting to lower either fasting or postprandial blood glucose while treating patients with type 2 diabetes mellitus, so as to reduce long term risks associated. From this analysis, it has been shown that postprandial blood glucose predicted overall glycemic control better than fasting blood glucose.

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