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Research Article

A CORRELATION STUDY OF BLOOD HBA1C WITH FASTING AND POSTPRANDIAL BLOOD GLUCOSE

PANKAJ KUMAR[1], ABHAY NILKANTH NAGDEOTE[2], PARUL GUPTA[3], AVINASH N JADHAO[4]

[1]Department of Biochemistry, VIMS Palghar, Maharashtra, India. [2]Department of Biochemistry, ESIC Medical College and Hospital MIA, Alwar, Rajasthan, India. [3]Department of Rasashastra, GACH, Patna, India. [4]Department of Biochemistry, Seth GSMC and KEMH Parel, Mumbai, Maharashtra, India. *Corresponding Author: Avinash N. Jadhao; Email: avinashjadhao@kem.edu

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ABSTRACT

Objectives: This study aimed to evaluate the correlation between raised blood sugar and glycated hemoglobin (HbA1c), a gold standard test for the assessment of glycemic control. Serial monitoring of HbA1C in diabetes mellitus helps in the prevention of microvascular and macrovascular complications.

Methods: We retrospectively reviewed the laboratory reports of 397 patients who visited the hospital for various reasons. There were 195 males and 202 females in the study group. We evaluated the correlation between HbA1c and two indicators of glycemic control: fasting blood glucose (FBG) and postprandial blood glucose (PPBG).

Results: Both FBG and PPBG showed a significant positive correlation with HbA1c. However, PPBG had a stronger correlation with HbA1c than FBG. The Spearman's correlation coefficient (r) was 0.610 ($p<0.05$) for FBG and HbA1c and 0.683 ($p<0.05$) for PPBG and HbA1c.

Conclusions: PPBG was a better predictor of HbA1c than FBG. PPBG may be an alternative marker of HbA1c for the management and monitoring of diabetes mellitus.

Keywords: Blood glucose, HBA1C, Postprandial

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INTRODUCTION

Diabetes mellitus is a long-term severe health issue that affects millions of individuals around the world [1]. It is a condition where the blood sugar level is too high, either because the pancreas does not produce an adequate concentration of hormone insulin, or the insulin receptors do not respond to insulin. Diabetes mellitus can lead to many complications such as retinopathy, nephropathy, neuropathy, and atherosclerosis [2]. Therefore, it is essential to diagnose and treat diabetes mellitus as early as possible and to monitor the blood sugar level regularly to prevent further complications [3].

One of the methods to measure the blood sugar level over a long period is HbA1c, which stands for glycated hemoglobin. It is a type of hemoglobin that binds to glucose in the blood. The higher the blood sugar level, the more HbA1c is formed. HbA1c reflects the concentration of blood glucose level over the past 8–12 weeks, depending on the lifespan of red blood cells [4]. HbA1c is a valuable tool for screening and managing diabetes mellitus, especially Type 2 diabetes mellitus, which may not have obvious symptoms. It also helps to evaluate the risk of developing microvascular complications, such as retinopathy and nephropathy, which are caused by high blood sugar damaging the small blood vessels in the eyes and kidneys. HbA1c is related to the formation of advanced glycation end products, which are harmful substances that can impair the function of various tissues and organs. Advanced glycation end products (AGEs) are formed when glucose reacts with proteins or lipids in a non-enzymatic process. AGEs can accumulate in the extracellular matrix, blood vessels, nerves, kidneys, eyes, and other organs, causing structural and functional damage. AGEs can also bind to specific receptors (RAGEs) and trigger inflammatory and oxidative stress responses, which can further aggravate the complications of diabetes and other chronic disease [5].

A decrease in blood HbA1c concentration decreases the development and progression of retinopathy, nephropathy, and neuropathy, in both DM Type 1 and DM Type 2 [6]. A total of 30–35% reduction in microvascular complications and a 14–16% decrease in macrovascular complications occur for every 1% absolute reduction in HbA1c [7]. Monitoring of plasma glucose levels in patients with diabetes can be assessed by measurement of HbA1c, fasting blood glucose (FBG), and postprandial blood glucose (PPBG). Even though the measurement of HbA1c remains the gold standard for the assessment of glycemic control, there is no consensus on whether FBG or PPBG is a better predictor of glycemic control in resource-poor settings where HbA1c is not available.

The objective of this study was to find a correlation between FBG and PPBG with HbA1c.

METHODS

We conducted a retrospective study of patients from our hospital who underwent blood glucose and HbA1c testing between August 2016 and September 2017. We followed the Helsinki Declaration and obtained ethical approval from the institutional review board. We extracted the patient's demographic and laboratory data from their medical records. We measured the blood glucose levels in the morning before breakfast (fasting) and 2 h after breakfast (postprandial) using a glucose oxidase peroxidase (GOD-POD) method on an auto-analyzer. We measured the HbA1c levels using high-performance liquid chromatography (HPLC) on EDTA-anticoagulated blood samples.

Statistics

Statistical analyses were done using GraphPad Prism 9. Shapiro–Wilk test is used to check the normality of the continuous variables. Wilcoxon signed-rank test to compare the levels of two indicators: fasting and

Table 1: The demographics of patients

Parameters	Subjects
Sex (Male/Female)	195/202
Age in years (Mean±SD)	48.56927±11.10161

SD: Standard deviation

Table 2: Fasting and postprandial blood glucose level

Parameters	Mean±SD
FBG (mg/dl)	129.73±67.952*
PPBG (mg/dl)	188.21±93.466*

*p<0.05.
SD: Standard deviation

Table 3: Spearman's correlation coefficients (r) of different parameters

Parameters	HbA1c
FBG	0.610*
PPBG	0.683*

*Correlation is significant at the 0.05 level.
FBG: Fasting blood glucose, PPBG: Postprandial blood glucose

postprandial blood glucose levels. Spearman's correlation coefficient (r) is to assess the correlation between fasting and postprandial plasma glucose and HbA1c levels.

RESULT

We included 397 patients in our study, with 195 males and 202 females. The age range of the patients was 11–79 years, with a mean of 48.57 years (Table 1). The mean FBG level was 129.73 mg/dl and the mean postprandial blood glucose level was 188.21 mg/dl. The difference between the two was statistically significant (Table 2). The Spearman's correlation coefficient (r) between FBG and HbA1c was 0.610 ($p<0.05$) and between postprandial blood glucose and HbA1c was 0.683 ($p<0.05$) (Table 3). Scatter plots of FBG and PPBG with HbA1C show a positive correlation (Figs. 1 and 2).

DISCUSSION

HbA1C is a standard measure of blood sugar levels over time. However, it can be affected by many factors such as blood disorders, cancer, genetic variations, drugs, pregnancy, and other medical conditions that make HbA1C unreliable in these cases [8]. Moreover, HbA1C is expensive and not widely available in many health-care settings, especially in developing countries. Therefore, we need an alternative marker that can reflect blood sugar levels in situations where HbA1C is not reliable or accessible. Furthermore, HbA1C only indicates long-term blood sugar control and does not provide any information about short-term fluctuations. Hence, we need a biochemical marker that can capture short-term alterations in blood sugar levels.

The main finding of this study is that both FBG and postprandial blood glucose (PPBG) correlated significantly with HbA1C. However, PPBG had a stronger correlation with HbA1C than FBG. This finding is consistent with the conclusion of Rosediani *et al*., 2006 who found that PPBG was a better predictor of HbA1C than FBG [9].

These findings have important implications for the diagnosis, management, and monitoring of diabetes mellitus (DM). It is well known that lowering HbA1C values can reduce the risks of DM complications, however, many primary healthcare facilities, especially in rural areas, does not have reliable screening and treatment options for DM. This leads to poor diabetes care and outcomes. Rural populations are more likely to suffer from complications of Diabetes mellitus than their urban population.

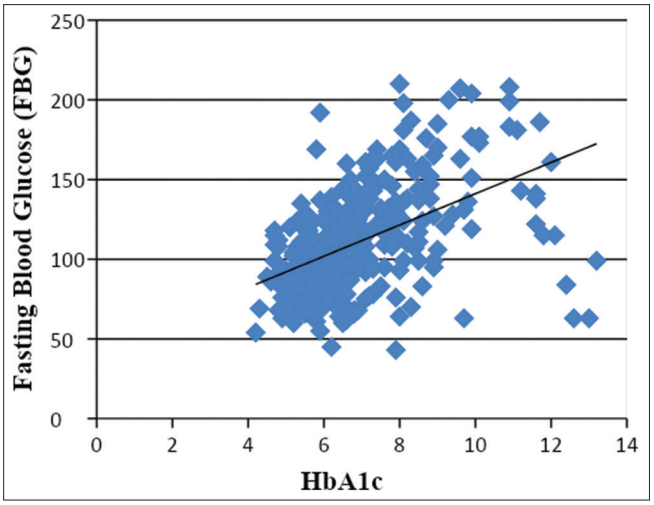

Fig. 1: Scatter plot of FBG and blood HbA1c

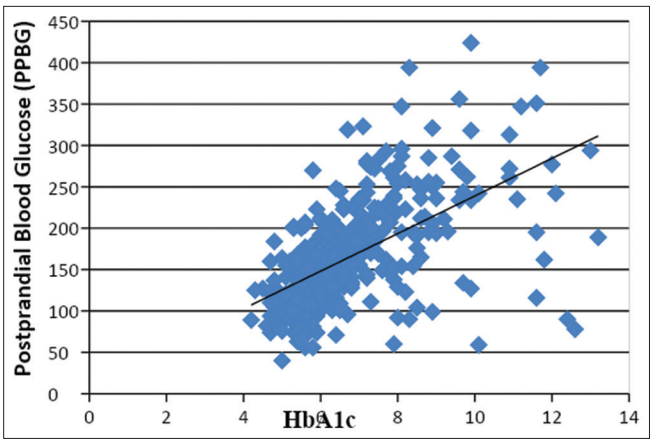

Fig. 2: Scatter plot of PPBG and blood HbA1c

HbA1c is a widely used test for insulin initiation and dose adjustments [9]. However, it is not easily available at primary health-care centers to many people due to its high cost. This poses a challenge for screening, managing, and monitoring diabetes mellitus in a developing country like India. Therefore, FBG and PPBG can be alternative indicators of blood glucose levels. PPBG has a stronger correlation with HbA1c than FBG, and thus, it can help in selecting appropriate medication to lower HbA1c value, that is, targeting PPBG to lower HbA1c. This study only included patients who visited the hospital for check-ups, which is a limitation of the current study.

CONCLUSION

This study showed that postprandial blood glucose had a better correlation with HbA1c than FBG level. In the absence of an HbA1c facility or unreliable HbA1c report, postprandial blood glucose can be a surrogate marker of HbA1c for the management and monitoring of diabetes mellitus, still, a more extensive study is needed to confirm this finding.

CONFLICT OF INTEREST

None.

AUTHOR'S CONTRIBUTION

Dr.Pankaj Kumar and Dr.Abhay Nilkanth Nagdeote: Data analysis and draft preparation, Dr.Parul Gupta & Dr.Avinash Jadhao: Data collection and compilation.

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