



Original Research Article

Correlation of glycated haemoglobin with fasting and post prandial blood glucose in Type 2 diabetes

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ABSTRACT

Background: Diabetes mellitus is a group of metabolic disorders characterized by high blood sugar levels and this chronic hyperglycemia is responsible for most of the complications of the disease. Glycated haemoglobin or HbA1C is a marker of this hyperglycemia and its complications. The aim of this study is to find out the correlation between HbA1C and FBS, PPBS and hence its effectiveness in assessing the glycemic control in type 2 diabetic patients.

Materials and Methods: In this cross sectional study, FBS, PPBS and HbA1C values were recorded in the study population which includes 605 type 2 diabetic patients visiting the hospital. FBS and PPBS were estimated using GOD- POD method. HbA1C was analyzed using particle enhanced immunoturbidimetric method and the data analysed and correlated with FBS and PPBS.

Results: There was a significant correlation between FBS, PPBS and HbA1C in the study population. It has also been found that PPBS shows a marginally better correlation(0.79) with HbA1C than FBS(0.77). This emphasizes the role of HbA1C as an indicator of blood glucose control, as it correlates well with FBS and PPBS.

Conclusion: Maintenance of strict glycemic control retards the development of complications of diabetes, which improves the quality of life of a diabetic patient. This glycemic control can be assessed with reasonable accuracy using HbA1C, as it has been found to correlate well with FBS and PPBS levels, more so with the PPBS levels.

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1. Introduction

Diabetes mellitus (DM), commonly known as diabetes, is a group of metabolic disorders characterized by a high blood sugar level over a prolonged period of time.¹ Diabetes is caused either by the inability of the pancreas to produce adequate insulin due to loss of beta cells² as in type 1 diabetes or the cells of the body not responding effectively to the insulin produced³ due to insulin resistance seen in type 2 diabetes.

The prevalence of diabetes has almost doubled over the past four decades. In 2017, about 4 million deaths were caused worldwide⁴ that could be attributed directly to diabetes, due to high blood glucose levels in this condition

or indirectly to diabetes⁴ especially due to increased risks of cardiovascular disease and kidney failure which result in premature death in diabetic patients. The global number of diabetes cases is further estimated to increase by 48% between 2017 and 2045.⁴

If left untreated, diabetes can cause many complications.² Acute complications include diabetic ketoacidosis, hyperosmolar hyperglycemic state, or death.⁵ Serious long-term complications include cardiovascular disease, stroke, chronic kidney disease, foot ulcers, damage to the nerves, damage to the eyes and cognitive impairment.⁶ Therefore, the ultimate goal of treating a person with diabetes is to prevent the development of complications and thereby improving the quality of life and also increasing their longevity. These complications can be prevented by achieving strict

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glycemic control. There is considerable evidence from the studies done in the past that achieving glycemic control by reducing the blood glucose levels is instrumental in decreasing the microvascular complications of diabetes namely neuropathy, nephropathy and retinopathy. Every 1% reduction in HbA1c is said to result in more than 35% decrease in risk of microvascular complications and around 20% decrease in the risk of death related to diabetes.^{7,8} Hyperglycemia can be assessed using HbA1C test, which has its own limitations in that it is expensive and quite unreliable in conditions that reduce the erythrocyte lifespan like G6PD deficiency, Sickle cell anemia and in hemoglobinopathies. Most of the studies done in the past have revealed that HbA1C levels correlate well with the fasting blood glucose (FBS) levels⁹ though few other studies show better correlation with post prandial blood glucose (PPBS).¹⁰ These contradicting studies leave us apprehensive about the correlation of HbA1C with FBS and PPBS. Hence, the aim of the present study was to find out the correlation of HbA1C with FBS and PPBS, thus assessing their utility in monitoring the glycemic control.

2. Materials and Methods

This cross sectional study was conducted at Sri Muthukumaran Medical College Hospital and Research Institute, Chennai, India from June 2018 to May 2019. The data collection which includes FBS, PPBS, RBS and HbA1C values of around 605 type 2 diabetic patients was done. This includes 280 males and 325 females. The mean age group of the study population was (51.32±14.6). Blood Glucose was estimated using GOD POD method using fully automated analyzer Konelab 20 of Trivitron healthcare. HbA1C was estimated using Particle enhanced immunoturbidimetric method with ERBA Mannheim XL system pack in the ERBA Chem 7 analyzer

2.1. Statistical methods

The different parameters were compared using SPSS software and Pearson's correlation, 'p' value < 0.05 was considered to be statistically significant.

3. Results

The fasting (FBS) and the postprandial (PPBS) blood glucose values of the samples showed a significant correlation as seen in Tables 1 and 2. The FBS and HbA1C values were then compared, which again showed a significant correlation as seen in Tables 3 and 4. HbA1C values also showed a very good correlation with PPBS values as seen in Tables 5 and 6. However, the correlation of HbA1C with PPBS was marginally higher when compared with that of FBS. Thus, it can be concluded that HbA1C can be used as an indicator of blood glucose control as it correlates well with FBS and PPBS. The advantage of HbA1C over FBS and PPBS is that

any random sample can be collected for HbA1C estimation while FBS and PPBS require sample collection at specified time periods.

Table 1: Paired samples statistics of FBS and PPBS

	Mean	N	Std. Deviation	Std. Error Mean
FBS	171.6714	605	89.29408	17.00382
PPBS	255.5288	605	111.4814	24.19715

Table 2: Paired samples correlation between FBS and PPBS

	N	Correlation	Sig.
FBS & PPBS	605	0.8834	.000

Table 3: Paired samples statistics of FBS and HbA1C

	Mean	N	Std. Deviation	Std. Error Mean
FBS	171.6714	605	79.67988	14.93794
HbA1C	7.24285	605	1.379213	0.256718

Table 4: Paired samples correlation between FBS and HbA1C

	N	Correlation	Sig.
FBS & HbA1C	605	0.77	.001

Table 5: Paired samples statistics of PPBS and HbA1C

	Mean	N	Std. Deviation	Std. Error Mean
PPBS	255.5288	605	112.8734	22.29583
HbA1C	7.24285	605	1.451795	0.284765

Table 6: Paired samples correlation between PPBS and HbA1C

	N	Correlation	Sig.
PPBS & HbA1C	605	0.7925	.001

4. Discussion

Diabetes mellitus is a chronic illness which is much prevalent in the Indian population. So far, the non communicable diseases were thought to affect the western population to a larger extent, but recent studies reveal that the incidence of non communicable diseases have taken over the communicable diseases even in the developing countries. Diabetes mellitus is a chronic disease that requires lifelong treatment and lifestyle modifications that are aimed at preventing the occurrence of acute complications and reducing the risk of long

term microvascular and macrovascular complications, thus improving the quality of life of the patient. The complications of the disease can be averted to a large extent by maintaining improved blood glucose control. This emphasizes the need for development of effective assessment methods for monitoring the blood glucose control which includes fasting blood sugar (FBS), postprandial blood sugar (PPBS) and glycated haemoglobin (HbA1C). While a case of diabetes is diagnosed with FBS, PPBS and HbA1C values, just the assessment of HbA1C, can be done for the follow up of these patients. If the concentration of glucose is high in the blood, it glycosylates the proteins like haemoglobin and albumin. The glycosylated haemoglobin is an indicator of the blood glucose levels over the past 3 months, as the lifespan of an erythrocyte is about 3 months. The microvascular complications of diabetes are caused by the accumulation of AGEs (Advanced Glycation End products)^{11–13} and HbA1C levels are a predictor of development of these complications as it reflects the extent of glycation.

HbA1C measurement becomes unreliable in a wide variety of conditions.^{14,15} In Iron and B12 deficiencies which affect the process of erythropoiesis, the HbA1C values may not be very useful. Again, the presence of hemoglobinopathies and variant haemoglobins make the HbA1C values unreliable. Diseases like Chronic renal failure, alcoholism, conditions that increase or decrease the life span of RBC like splenectomy, splenomegaly and use of antiretroviral drugs have been found to affect the HbA1C levels. Hyperbilirubinemia and hypertriglyceridemia were also found to profoundly affect HbA1C values.

Thus, HbA1C cannot be accepted as a screening tool due to its high cost and the difficulty in standardization, in the setting of point of care testing, where it does not show acceptable analytical performance.^{16–18} This standardisation, can however be achieved by following the IFCC standards and the laboratories should follow standardized methods and use analyzers that are traceable to the globally accepted reference systems.

Studies done in the past have proved that the FBS levels correlate well with HbA1C. It was even considered that HbA1C was an indicator of FBS levels. However, in our study, we have found that PPBS shows a marginally better correlation with HbA1C than FBS. When a comparison is made on the ease of sample collection among PPBS and FBS, the sample for PPBS is relatively easy to collect as it doesn't require overnight fasting. There is evidence to suggest that PPBS is a better indicator of development of macrovascular complications, especially the cardiovascular complications.¹⁹

Hence there is a direct correlation between blood glucose and HbA1C levels. However, according to the American Diabetes Association, Fasting Plasma Glucose is the diagnostic test for diabetes as the PPBS values are subject to lots of variation like physical activity, the gastric

emptying and even the composition of the meals^{15,16} and FBS is a predictor of hepatic gluconeogenesis.²⁰ HbA1C is not used as a diagnostic test for diabetes as it does not reflect the true blood glucose values, especially in conditions that affect the haemoglobin structure and function. This is the main cause for HbA1C being less reliable than FBS and PPBS. In spite of all these shortcomings, HbA1C can still be very useful in monitoring the blood glucose control.

5. Conclusion

It has been proved beyond doubt that the glycaemic control of a person can be assessed with reasonable accuracy using HbA1C. However, this method has got its own limitations in that it is more expensive than the conventional FBS and PPBS estimations and that the method requires proper standardization to be reliable. It also has its own advantages in that the sample collection for this test doesn't cause much inconvenience to the patient as it only requires a random sample that can be collected any time, unlike FBS and PPBS samples that have to be collected at specified periods of time. If HbA1C cannot be estimated due to limited resources, FBS and PPBS estimations can be done. It is worth reemphasizing that maintenance of good glycaemic control plays a very important role in preventing the development of complications related to diabetes, thus improving the quality of life of diabetic patients.

6. Source of Funding

None.

7. Conflict of Interest

None.

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