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Original Research Article

Relationship between glycated hemoglobin and blood glucose levels in fasting and two hours after 75 g oral glucose in gestational diabetes mellitus

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ABSTRACT

Background: Oral glucose tolerance test (OGTT) performed at 24-28 weeks gestation is the current recommended method to the diagnosis of gestational diabetes mellitus (GDM). Many recent studies investigating glycated hemoglobin (HbA1c) in detecting GDM yield different results. There are no published data on HbA1c in the diagnosis of GDM in India.
Methods: A cross-sectional study was carried out at T.N.M.C. Mumbai during the period from January to June 2021 to assess the reliability of HbA1c in the diagnosis of GDM.
Results: We included 397 pregnant females. The age range of the patients was 18 to 35 years, with a mean of 24.57±11.10 years. The mean fasting blood glucose level was 129.73 mg/dl and the mean 2 hours after 75 g oral glucose level was 188.21 mg/dl. The difference between the two was statistically significant. The Spearman's correlation coefficient (r) between fasting blood glucose and HbA1c was 0.610 ($p<0.05$) and between postprandial blood glucose and HbA1c was 0.683 ($p<0.05$). Scatter plots of FBG and 2 hours after 75 g oral glucose with HbA1C shows a positive correlation.
Conclusions: This study showed that 2 hours after 75 g oral glucose had a better correlation with HbA1c than fasting blood glucose level. In the absence of HbA1c facility or unreliable HbA1c report, postprandial blood glucose can be a surrogate marker of HbA1c for management and monitoring of gestational diabetes mellitus, but a larger study is needed to confirm this finding.

Keywords: Gestational diabetes mellitus, HbA1c, Marker

INTRODUCTION

Gestational diabetes mellitus (GDM) is defined when glucose intolerance resulting in different severity level of hyperglycaemia is discovered during gestation/ pregnancy.[1] GDM is one of the common public health problems worldwide, and its prevalence is expected to increase dramatically.[2,3] GDM is one of the leading causes of adverse maternal and fetal outcomes such as hypertensive disorders of pregnancy, increased caesarean delivery rate, foetal overgrowth, type 2 diabetes, cardiovascular diseases in later life in mothers, and increased risk for macrosomia.[4,5] The current standard test for diagnosing GDM is the oral glucose tolerance test (OGTT), which is done between 24 and 28 weeks of pregnancy. This test requires fasting for 10 hours, waiting for at least two hours, and having multiple blood samples taken. HbA1c is a measure of how much glucose is

attached to haemoglobin, the protein that carries oxygen in red blood cells. It reflects the average blood glucose level over the past three months. It is commonly used to diagnose and monitor diabetes in non-pregnant people, according to international guidelines from the American Diabetes Association and the International Expert Committee on Diabetes.[6] HbA1c may also help to identify women who have preexisting diabetes before they become pregnant.[7-9] Several studies have found that women with GDM have higher HbA1c levels than women without GDM.[10-14] High HbA1c levels during pregnancy are also linked to poor outcomes for the baby, such as birth defects, large birth weight, and low blood sugar.[4,15] However, the reliability and accuracy of HbA1c for diagnosing GDM is not consistent across different studies. Some studies have reported that HbA1c is not a good indicator of GDM, while others have reported that HbA1c is a good or excellent indicator of GDM.[10,12,14,16-21]

The diagnosis of GDM in Indian women is challenging due to the lack of standardized criteria and the high prevalence of the condition. One of the possible biomarkers for GDM is glycated hemoglobin (HbA1c), which reflects the average blood glucose level over the past two to three months. However, there is a scarcity of published studies on the validity of HbA1c for diagnosing GDM in the Indian population of our region. Therefore, we conducted this study to evaluate the accuracy and reliability of HbA1c for detecting GDM among Indian women.

METHODS

This study was a retrospective study in which 397 pregnant Indian women with singleton pregnancy who visited the antenatal care. The study period was January to June 2021 in T.N.M.C and B.Y.L. Nair Hospital Mumbai. They were eligible to participate if they were at least 18 years old, healthy (without any medical condition), in their second trimester (24 to 28 weeks of gestation) and following a normal diet (without any restriction). They provided informed consent before joining the study. Women who smoked, chewed tobacco, or had chronic diseases such as severe anaemia (haemoglobin <7 g/dl), hypertension, type 1 or type 2 diabetes, renal disease, thyroid disease, and liver disease, or who were on chronic medication were excluded. The study followed a professional tone as requested.

We used a questionnaire to collect information on the age, parity, gestational age, education, residence, diabetes history, miscarriage history, and intrauterine fetal death history of the women. We also measured their weight and height and calculated their body mass index (BMI) as weight in kg/ (height in m)^2. We performed a 75-gram oral glucose tolerance test after 10 hours of overnight fasting. We collected 5 ml of blood in fluoride vacutainer before and after 1 and 2 hours of oral glucose intake. We also collected 5 ml of blood in ethylenediaminetetraacetic acid vacutainer for measuring glycosylated haemoglobin. We diagnosed GDM according to the International Association of Diabetes and pregnancy study groups (IADPSG) criteria "fasting blood glucose (FBG) ≥92 mg/dl or 1-hour blood glucose ≥180 mg/dl and/ or 2-hour blood glucose ≥153 mg/dl, after 75-g oral glucose load".[23] We used the glucose oxidase method to measure the glucose level following the manufacturer's instructions (Shino-Test Corp.). We calculated the sample size of 397 women to achieve the desired sensitivity (90%), and specificity (70%) for the prevalence (15%) of GDM among the screened women. This sample would provide 80% power to detect type I error (i.e., p value <0.05), with the assumption that 10% of the women might have incomplete data or insufficient samples.

RESULTS

We included 397 pregnant females. The age range of the patients was 18 to 35 years, with a mean of 24.57±11.10 years (Table 1). The mean fasting blood glucose 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 fasting blood glucose 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 shows a positive correlation (Figures 1 and 2).

Table 1: The demographics of patients.

Parameters	Subjects
Total pregnant females	397
Age in years (mean±SD)	24.57±11.10

SD=Standard deviation

Table 2: Fasting and postprandial blood glucose level.

Parameters	Mean±SD
FBG (mg/dl)	129.73±67.952*
Blood glucose 2 hours after 75 g oral glucose (mg/dl)	188.21±93.466*

*P<0.05

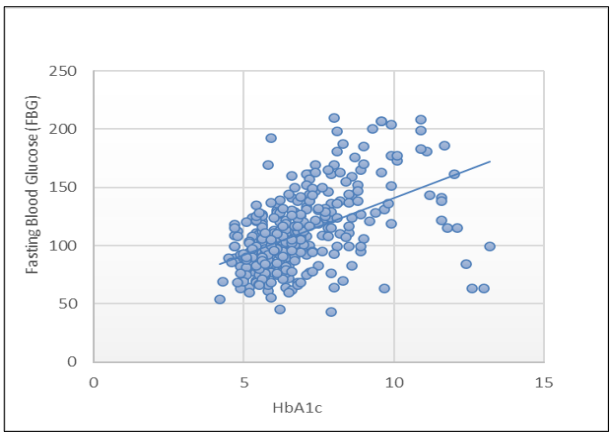

Figure 1: Scatter plot of FBG and blood HbA1c.

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

Parameters	HbA1c
FBG	0.610*
Blood glucose 2 hours after 75 g oral glucose	0.683*

*Correlation is significant at the 0.05 level

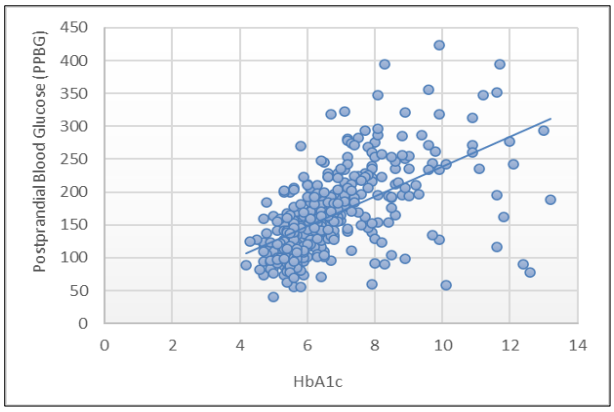

Figure 2: Scatter plot of blood glucose 2 hours after 75 g oral glucose (mg/dl) and blood HbA1c.

DISCUSSION

HbA1C is a widely used indicator of glycaemic control over a period of several weeks or months. However, this marker has several limitations that affect its accuracy and applicability in some situations. For example, HbA1C can be influenced by hemoglobinopathies, malignancies, genetic variants, medications, pregnancy, and other comorbidities that alter the lifespan or structure of red blood cells.[22] In addition, HbA1C is costly and requires specialized equipment and trained personnel, which limits its availability and accessibility in many resource-limited settings. Therefore, there is a need for an alternative marker that can reliably reflect glycaemic status in cases where HbA1C is not valid or feasible. Moreover, HbA1C does not reflect short-term variations in blood glucose levels, which can have important implications for the risk of complications and the management of diabetes. Hence, there is a need for a marker that can detect acute changes in glycaemic levels.

This study revealed that HbA1C, a marker of long-term blood glucose control, was significantly associated with both FBG and blood glucose 2 hours after 75 g oral glucose (mg/dl). However, the association was stronger for Blood glucose 2 hours after 75 g oral glucose (mg/dl) than for FBG. This result agrees with the finding of Rosediani et al, 2006 who reported that PPBG was a more accurate predictor of HbA1C than FBG.[23]

One of the common tests for adjusting insulin therapy and initiating it is HbA1c.[24] However, many people cannot afford this test because it is expensive. This makes it difficult to screen, manage and monitor Diabetes mellitus in India, which is a developing country. FBG and PPBG are other ways to measure blood glucose levels. PPBG is more related to HbA1c than FBG, and so it can help in choosing the right medicine to reduce HbA1c level, i.e., lowering PPBG to lower HbA1c. The patients in this study only came to the hospital for a check-up, which is a drawback of this study.

The aim of this study was to examine the relationship between HbA1c and blood glucose levels in pregnant women with GDM. We found that HbA1c was positively correlated with fasting blood glucose and postprandial blood glucose at 1 and 2 hours. This is consistent with a previous study that reported positive correlations between HbA1c and fasting blood glucose and 2 hours postprandial blood glucose in GDM.[14] However, we should be careful when comparing our results with other studies, as different studies used different diagnostic criteria for GDM.[25,26] Furthermore, the high prevalence of anaemia (27.3%) in our study may have affected the accuracy of HbA1c for the diagnosis of GDM. Anaemia has been proposed as one of the reasons for lower HbA1c levels in pregnant women.26 HbA1c reference ranges may also vary depending on gestational age, ethnicity, genetic factors, and exposure to different risk factors.[27-29] Additionally, a recent study reported that HbA1c testing during pregnancy was not cost effective as a screening method for GDM.[30]

A limitation of this study is that it was conducted in a single center with a relatively small sample size, which may limit the generalizability of the results. Further studies with larger and more diverse populations are needed to confirm our findings and to identify the optimal cut-off values of HbA1c and blood glucose levels for diagnosing and managing GDM.

CONCLUSION

This study showed that 2 hours after 75 g oral glucose had a better correlation with HbA1c than fasting blood glucose level. In the absence of HbA1c facility or unreliable HbA1c report, postprandial blood glucose can be a surrogate marker of HbA1c for management and monitoring of gestational diabetes mellitus, but a larger study is needed to confirm this finding.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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