

A comparative study of glucose concentration determined from venous plasma sample and capillary blood sample

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Abstract

Context: Self-monitoring of glucose levels with a hand held glucometer is very popular among the diabetic patients and doctors as it is less traumatic and gives instant results. Capillary blood samples are commonly used for self-monitoring in comparison to venous plasma sample which are used in the diagnostic laboratories.

Aims: This study was done to compare the glucose levels of a capillary blood sample determined by a glucometer with the glucose level determined by Glucose Oxidase Peroxidase (GOD-POD) method using a venous plasma sample.

Setting and Design: This experimental study was carried out at Rohilkhand Medical College and Hospital.

Methods and Material: Two hundred patients were randomly selected for the study. Their venous blood samples were collected in a fluoride containing blood collection tube. The plasma obtained was subjected to GOD-POD test. Simultaneously their capillary blood glucose was also determined by a glucometer.

Statistical analysis used: The data collected was analyzed using SPSS 17.0 version. Data was expressed as mean \pm SD. Significance of mean was analyzed using paired t test. P value < 0.05 was considered significant.

Result: Glucose levels determined by a glucometer and GOD-POD method showed very good correlation ($r=0.958$; $p<0.001$). However, at very high and low glucose levels, the glucometer significantly under estimated ($p=0.014$) and over-estimated ($p<0.001$) the glucose levels respectively.

Conclusion: Although glucometers are effective for routine monitoring of glucose levels, they should be used cautiously in emergency conditions.

Keywords: Glucose levels, GOD-POD method, Glucometer

Manuscript Received: 29th April, 2017

Manuscript Accept: 24th May, 2017

Introduction

Diabetes Mellitus (DM) is a chronic disorder and a global health issue. At present about 20 to 30 million people in India are diagnosed to have DM. This figure is expected to rise to about 80 million by 2030.^(1,2) As Diabetes Mellitus is associated with life threatening acute and chronic complications, there is a need of a continuous and a stringent management of diabetic patients. Maintaining the plasma glucose level within the acceptable range is one of the most important component of diabetic management. Various laboratory methods are available to determine the glucose levels. One of the common methods performed in many laboratories is the glucose oxidase peroxidase (GOD-POD) method which is done in the laboratory with the plasma and has a turnaround time of about 30 to 45 minutes.⁽³⁾ Another very popular approach for continuously monitoring the blood glucose levels is the self-monitoring of blood glucose by a glucometer. This point of care testing (POCT) allows reduced therapeutic turnaround time, reduced pre-analytic and post-analytic testing errors, rapid data availability, self-contained and user-friendly instruments and convenience to both the doctor and the patient.^(4,5) They are also commonly used in emergency condition especially in unconscious patients and neonates where the glucose levels can be

determined instantly and treatment can be initiated immediately. Although common and popular, the glucose level determined by the whole blood or capillary blood using a glucometer shows variation when compared with the results obtained from a venous blood. The capillary blood used in the glucometer usually give higher estimates of glucose level in comparison to the plasma sample due to lower water content.^(6,7,8) Moreover, WHO and the American Diabetes Association (ADA) has specified the criteria for diagnosis of DM and impaired glucose tolerance for only venous plasma sample.^(9,10) In view of the above, this study was done to compare the glucose levels in capillary samples using a glucometer and plasma sample using GOD-POD method and compare the results obtained by them.

Materials and Method

This study was carried out on the patients attending the OPD, camps and those admitted in the ICU and casualty at Rohilkhand Medical College and Hospital, Bareilly between March 2016 and July 2016. Ethical committee clearance and patients consent were taken before commencing the study. Random glucose concentration of the participants between 25 to 62 years of age was determined using a glucometer with the

capillary blood collected by applying a small needle prick to the middle or ring finger under aseptic conditions. Simultaneously, two ml of venous plasma sample was collected in a fluoride containing collecting tube. The venous sample was then centrifuged at 2000 to 3000 rpm for about seven minutes in order to separate the plasma. The plasma obtained was used to estimate the glucose concentration by Glucose Oxidase Peroxidase method using ERBA 360 auto analyzer. The glucometer used for the study used test strips which included Glucose dehydrogenase-PQQ (Acinetobactercalcoaceticus), mediators, buffers and stabilizers. The results were displayed as plasma glucose levels. Both the auto analyzer and the glucometer were calibrated before every lot of samples were analyzed.

Based on the glucose levels obtained by GOD – POD methods the patient were divided into 3 groups as follows:

Group 1: Plasma glucose concentration below 60 mg/dL

Group 2: Plasma glucose concentration between 61 to 299 mg/dL

Group 3: Plasma glucose concentration between 300 mg/dL and above

Data was analyzed using SPSS version 17.0. Value were expressed as mean \pm S.D. Paired t test was used to calculate the significance of the mean. P value less than 0.05 was considered significant.

Result

A total of 200 blood samples were collected and their glucose levels were determined by both the methods. Of the total participants, 67% were males and 33% were females. The age group of the participants ranged between 25 to 62 years. The mean glucose concentration determined by both the methods is summarized in Table 1. Although the glucometer showed slightly higher glucose level as compared to GOD method, this increase was statistically not significant. However, there was difference in the glucose concentration determined by both these methods in patient with low ($p < 0.001$) and very high glucose levels ($p = 0.014$). As evident from Table 1, the glucometer showed a higher glucose concentration in patients with glucose levels below 60 mg/dL. In patients with glucose level above 300mg/dL, the glucometer showed lower concentration. Both these differences were statistically significant. Pearson correlation co-efficient analysis showed very good statistically significant correlation between the two methods when the glucose levels were between 61 mg/dL to 299mg/dL (Fig. 1). When the glucose levels were below 60 mg/dL and above 299 mg/dL, both the method showed a weaker positive correlation which were statistically not significant (Fig. 2 & 3).

Table 1: Table comparing the mean glucose concentration by both the methods

	Determination of glucose concentration by		Significance (P Value)
	Glucose Oxidase Peroxidase method	Glucometer	
Mean glucose concentration of all the patients (n=200)	131.02 \pm 86.74	134.94 \pm 67.73	Not Significant
Patients with glucose concentration less than 60 mg/dL (by GOD –POD method) (n=14)	46.14 \pm 8.55	63.07 \pm 12.60	< 0.001
Patients with glucose concentration between 61 to 299 mg/dL (by GOD –POD method) (n= 174)	117.97 \pm 38.93	126.00 \pm 39.3	<0.001
Patients with glucose concentration more than 300 mg/dL (by GOD –POD method) (n=12)	419.25 \pm 99.05	346.0 \pm 37.90	= 0.014

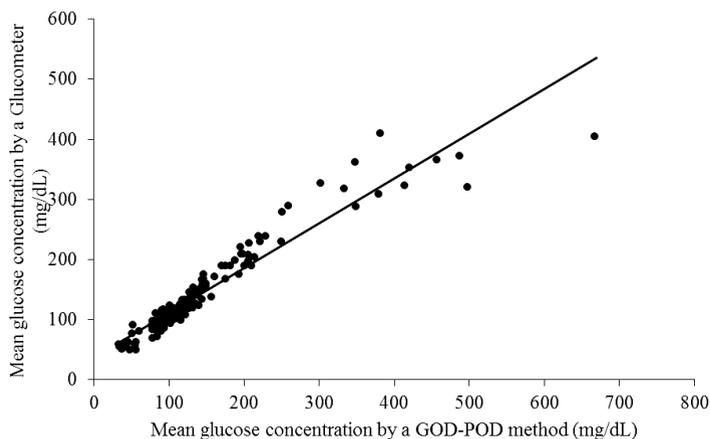


Fig. 1: A graph showing a correlation between glucose levels determined by a glucometer and by GOD-POD methods. ($r = 0.958$; p value < 0.001)

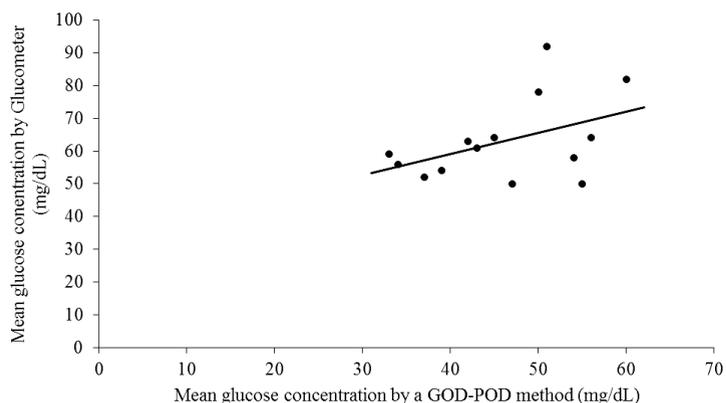


Fig. 2: A graph showing a correlation between glucose levels determined by a glucometer and by GOD-POD methods in patients with glucose level below 60 mg/dL. ($r = 0.438$; not significant)

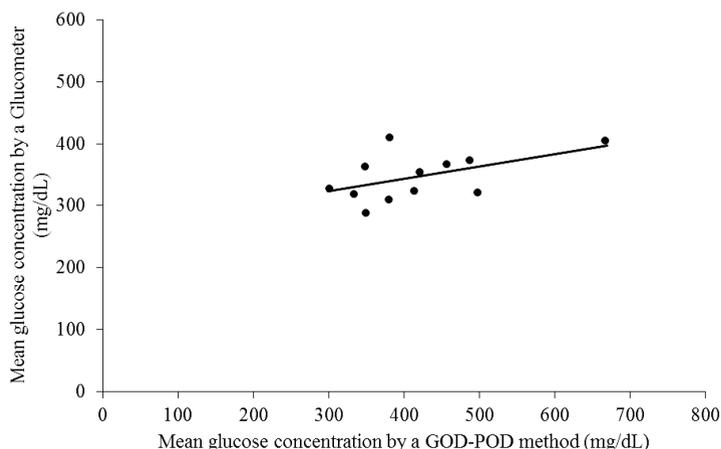


Fig. 3: A graph showing a correlation between glucose levels determined by a glucometer and by GOD-POD methods in patients with plasma glucose level above 300 mg/dL. ($r = 0.525$; not significant)

Discussion

Glucose meters or glucometers are hand held devices which are very commonly used for self-monitoring glucose levels. In recent years, due to

increase in the cases of impaired glucose tolerance or Diabetes Mellitus, the use of glucometer have become very popular as it is perceived as a simple and a fast method to determine the glucose levels. These

glucometer helps the patient to check his or her glucose level at home thus avoiding the need to go to a hospital or a diagnostic lab. In addition, these glucometers also helps the physician to determine the glucose level in his or her clinic and provide good quality treatment to the patient. This study was done in 200 participants with an intention to determine their blood glucose level by a glucometer and then compare it with the GOD-POD method which is commonly used in many diagnostic laboratories. The glucometer reading was recorded at the time of collection of plasma blood sample. This was done to ensure that there was no variation with respect to time. We found a good correlation between the glucose concentrations by both the method (Fig. 2). This correlation was the best when the glucose levels were between 61 mg/dL to 299 mg/dL. However when the glucose levels were below 60 mg/dL there was a poor correlation with no statistical significance (Fig. 3). Similar finding were reported by other studies in which a poor correlation was observed by both the methods in hypoglycemic condition.^(11,12,13) Most of these studies opined that at lower glucose concentration, the glucometer may not give accurate results. This may be because condition such as shock, severe hypotension and dehydration results in reduced peripheral blood circulation. As glucometer uses capillary blood, the samples obtained in these condition may not reflect the exact glucose levels hence affecting its reliability.^(14,15) In samples where the glucose concentration determined by GOD – POD method was above 300mg/dL, once again there was a poor correlation with no statistical significance with the results obtained from a glucometer. The glucometer under determined the glucose levels. Similar findings were reported by Baig et. al in their study on 110 samples.⁽¹⁶⁾ This is probably due to very high concentration of the substrate glucose which tends to saturate the enzyme glucose dehydrogenase present in the reagent strip of the glucometer. This results in false lower levels of glucose.^(17,18)

The guidelines laid down by ADA recommendations allows the glucometer to be determine the glucose level within 20% of the laboratory method at all concentration.^(19,20) This means as the glucose concentration increases the range of the acceptable glucose level by a glucometer also increases. This could be another reason why there was more variation in glucose levels determined by both the methods at a higher concentration. Apart from just the method of determination, the reliability of the results obtained from glucometer can be affected by many factors such as patient's condition, medication, environmental effects such as high altitude and other metabolic factors.⁽²⁰⁾ Therefore while interpreting the result from a glucometer all these pre-analytical variables should also be taken into consideration.

Conclusion

Currently management of DM focusses primarily on good glycemic control in order to prevent life threatening complication. Glucometers are commonly used to monitor glucose levels as they are less traumatic, easy to use, requires less expertise in comparison to laboratory method and has practically no turn-around time. Although they are useful for self-monitoring and keeping records of glycemic control, they should be used with caution in emergency hypoglycemic condition or in cases of hyperglycemia as they can over-estimate or under-estimate the glucose levels respectively. In these condition it is advisable to determine and confirm the glucose concentration in the laboratory.

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