Correlation between Fasting Blood Glucose and Postprandial Blood Glucose Level with HbA_{1c} in Type 2 Diabetic Patient Treated with Insulin

*Sheme ZA, [1] Huda AK,[2] Mosawuir MA,[3] Hoque S,[4] Pervin M,[5] Begum A,[6] Akhter L,[7] Khondokar F [8]

Now a day's number of diabetic patients is increasing rapidly. Glycemic control is the most important aspect in management of diabetes mellitus. We can assess the glycemic control by estimation of FBG, PPBG or HbA_{1c}. Our aim of this study was to see the relationship between FBG and PPBG with $HbA_{1c.}$ This cross-sectional study was conducted in the Department of Biochemistry, BIRDEM over a period of three months from December 2013 to February 2014. Total 68 patients treated with insulin were included in this study. Fasting blood glucose (FBG) and postprandial blood glucose (PPBG) were measured by Glucore Oxidase Perovidare (GOD-POD) method (Human, Germany) and HbA_{1c} was assessed by TINIA method (Dade Behring Auto analyser) according to the manufacturer's instructions. Data was expressed as Mean ± SD, number (percent) as applicable. Student's *t*-test, Pearson's correlation was performed by using statistical package for social science (SPSS) for windows version 11.5 and MedCalc Statistical software respectively. Within 68 cases 11 cases showed FBG less than 7 mmol/L and 57 showed FBG more than or equal 7 mmol/L and Mean ± SD was 6.11 ± 0.42 and 11.42 ± 4.93 respectively. 23 cases showed PPBG less than 11.1 mmol/L and 45 showed more than or equal 11.1 mmol/L and Mean ± SD was 8.26 ±1.51 and 16.89 ± 5.25 respectively. Pearson's Correlation was done between FBG and PPBG with $HbA_{1c.}$ HbA_{1c} Correlate moderately with both FBG (r=0.5234, P<0.000) and PPBG (r=0.5133, P<0.0001). In our study both FBG and PPBG correlate moderately well with HbA_{1c}. So, both are needed to assess the glycemic control and to reduce the risk of complication.

[Dinajpur Med Col J, 2017 Jul; 10 (2):239-243]

Key words: Diabetes mellitus, Glycosylated hemoglobin, Hyperglycemia, FBG and PPBG

Introduction

Diabetes mellitus is a group of metabolic disorders characterized by elevated plasma glucose level.[1] Control of blood glucose in patients with diabetes mellitus can be assessed by several methods. These include assessment of glycated hemoglobin (HBA_{1c}), fasting blood sugar (FBS), and postprandial blood sugar (PPBS). The gold standard for assessment of glycaemic control at follow up is the glycated haemoglobin level.[2] Diabetes mellitus is associated with major micro and macro vascular complications.[3] Many studies demonstrate that controlling plasma

1. * Dr. Zinat Afrin Sheme. Assistant Professor, Department of Biochemistry Rangpur Army Medical College, Rangpur. zinatafrinsheme@gmail.com
2. Dr. AKM Kamrul Huda MBBS, MS(surgery) in course, Rangpur Medical College.
3. Dr. Md. Abdullahil Mosawuir. Associate Professor, Department of Physiology, Rangpur Medical College, Rangpur, Bangladesh. dr.rumman@yahoo.com
4. Dr. Sayama Hoque. Assistant Professor, Department of Biochemistry, Khwaja Yunus Ali Medical College and Hospital, Sirajgonj.
5. Dr. Mahfuza Pervin. Assistant Professor, Department of Physiology, Prime Medical College, Rangpur
6. Dr. Afsana Begum, Lecturer, Department of Biochemistry, Mugda Medical College, Dhaka.
7. Dr Latifa Akhter. Assistant Professor, Department of Dermatology, Rangpur Medical College, Rangpur, Bangladesh.
8. Dr. Farzana Khondoker, Assistant Professor and Head of the Dept. of Physiology, Rangpur Army Medical College, Rangpur. fkhondoker102@gmail.com

For correspondence

glucose level could prevent the progression of these complications, especially micro vascular diseases.[4-6] 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.[7] Rate of glycosylated hemoglobin formation is proportional to the ambient blood glucose concentration. It has been seen that 1% rise of plasma glycosylated hemoglobin concentration corresponding to an average increase of blood glucose concentration by 2 mmol/L.[8] The American Diabetes Association(ADA) recommended cut off value for HbA_{1c} less than 7%, while the American Association of Clinical Endocrinology recommended less than 6.5%.[9,10]

Table 1: Several ways of diagnosis of diabetes mellitus

• HbA_{1c} level ≥ 6.5%.
• A casual (random) plasma glucose level ≥ 11.1 mmol/L(200 mg/dl) in someone with typical symptoms of diabetes.
• A fasting plasma glucose level ≥ 7.0 mmol/L (126 mg/dl) on several occasions.
• A plasma glucose level ≥ 11.1 mmol/L (200 mg/dl) 2 hours after a 75gm load of glucose given by mouth (the oral glucose tolerance test – OGTT)[11].

The objective of this study was to find correlation between fasting blood glucose, postprandial blood glucose and HbA_{1c} in HbA_{1c} in type 2 diabetic patient treated with insulin.

Methods

A cross-sectional study was conducted in the Department of Biochemistry, BIRDEM over a period of three months from December 2013 to February 2014. The inclusion criteria were patients with diagnosed DM type 2 diabetes on insulin treatment, no treatment change in the first day of their stay in the hospital, no changes in diet, or lifestyle within the three months before the admission, no concomitant chronic diseases or recent acute illness. Blood glucose was measured in fasting condition (8:00-8:30 A.M.) and in postprandial condition (10:00-10:30 A.M.) for 3 consecutive days by Glucore Oxidase Perovidare (GOD-POD) method (Human, Germany) and HbA_{1c} was assessed by TINIA method (Dade Behring Auto analyser) according to the manufacturer's instructions.

According to American Diabetic Association patients were divided into 2 groups regarding to HbA_{1c}. HbA_{1c} <7 % well controlled patient and poor control ≥7%.
Data was expressed as Mean ± SD, number (percent) as applicable. Student's *t*-test, Pearson's correlation was performed by using statistical package for social science (SPSS) for windows version 11.5 and MedCalc Statistical software respectively.

Result

A total 68 patients were included in this study. Of which 23 are male and 45 were female, with the minimum age 40 to maximum 67 years. Within 68 cases 11 cases showed FBG less than 7 mmol/L and 57 showed FBG more than or equal 7 mmol/L and Mean ± SD was 6.11 ± 0.42 and 11.42 ± 4.93 respectively. 23 cases showed PPBG less than 11.1 mmol/L and 45 showed more than or equal 11.1 mmol/L and Mean ± SD was 8.26 ±1.51 and 16.89 ± 5.25 respectively (Table II). Pearson's Correlation was done between FBG and PPBG with HbA_{1c} correlate moderately with both FBG (r =0.5234, P<0.0001) and PPBG (r=0.5133, P<0.0001) (Table III, Figure 1, 2).

Table II: Variable distribution

FBG	Number	Mean ± SD
< 7 mmol/l	11	6.11 ± 0.42
≥7 mmol /l	57	11.42 ± 4.93
Total	68	10.56 ± 4.92
PPBG		
< 11.1 mmol/l	23	8.26 ±1.51
≥11.1 mmol /l	45	16.89 ± 5.25
Total	68	13.97 ± 5.98
HbA_{1c} level		
<6.5%	10	6.12 ± 0.54
>6.5 %	58	9.26 ± 2.25
total	68	8.80 ± 2.36

HbA_{1c}= glycosylated hemoglobin, FBG= fasting blood glucose, PPBG= post prandial blood glucose

Table III: Pearson's Correlation between FBG and PPBG with HbA_{1c}

	Correlation Coefficient (r)	P value
HbA_{1c} Vs. 2h ABF	0.5133	P<0.0001
HbA_{1c} Vs FBG	0.5234	P<0.0001

HbA_{1c}= glycosylated hemoglobin, FBG= fasting blood glucose, PPBG= post prandial blood glucose, r = correlation coefficient.

P< 0.05 was taken as level of significance.

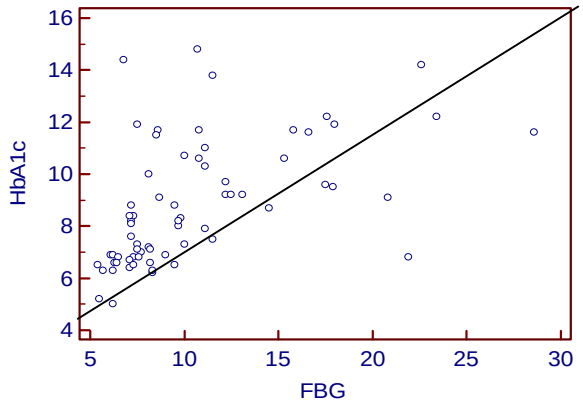

Fig 1. Correlation between FBG with HbA_{1c}

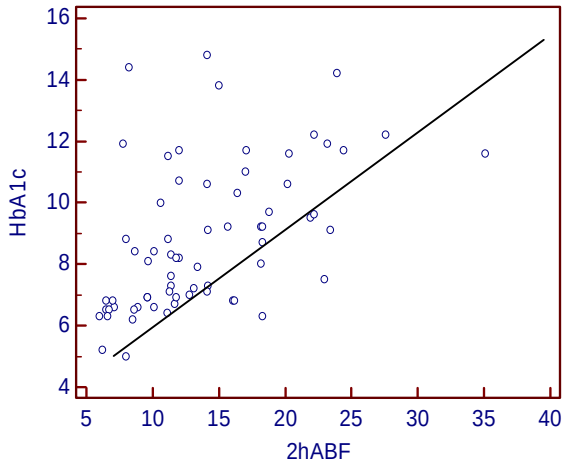

Fig 2. Correlation between PPBG with HbA_{1c}

Discussion

In this study, we correlated HbA_{1c} with fasting as well as post meal plasma glucose in type-2 diabetic patients. Both fasting and post-meal plasma glucose levels were found to be positively correlated with HbA_{1c}.

Fasting glycemia has traditionally been considered the main HbA_{lc} marker as suggested by the American Diabetes Association (ADA) and World Health Organization (WHO). Recently, however, the validity of this has been questioned, and it has even been suggested that the main marker is postprandial glycemic level.[12]

Monnier L, Colette C (2006),[13] reviewed previous studies of diurnal glycemic profiles and concluded that relative contribution of postprandial plasma glucose to HbA_{1c} was high (70%) in patients with fairly good control of diabetes (HbA_{1c} <7.3%) and decreased progressively (30%) with worsening diabetes (HbA_{1c} >10.2%) whereas the contribution of fasting plasma glucose showed a gradual increase with increasing levels of HbA_{1c}. Masram et al,[14] Waqar Azim et al,[15] and Rosediani M[16] who revealed that PPG has a stronger correlation with HbA_{1c} as compared to the FPG. A systematic review on "Guidelines for management of post meal

glucose" recommends that although control of fasting hyperglycaemia is necessary, it is usually insufficient to obtain optimal glycaemic control. Post meal hyperglycemia is associated with increased risk of retinopathy, increased carotid intima thickness, oxidative stress, inflammation and endothelial dysfunction. Hence targeting both post-meal and fasting plasma glucose is an important strategy for achieving optimal glycaemic control.[17] Some other studies also showed PPBG correlated more strongly with HbA_{1c} in comparison with FBG. Rosediani et al, 2006 showed that PPBG correlated better to HbA_{1c} than FBG.[18]. Various other studies that have found in their studies that postprandial and post challenge glucose levels correlate better with HbA_{1c} values than fasting blood glucose.[4,19,20] On the other hand, a study by Bonora et al, 2001, has stated that HbA_{1c} correlated more closely to pre-prandial than postprandial blood sugar.[21] Similar conclusions has been reached by Peter et al, 2006 and Goudswaard et al, 2004.[22,23]

In our study, moderate correlation was observed between HbA_{1c} and both fasting blood glucose and post prandial glucose, this finding is consistent with other studies[24,25,26]. Our study revealed that both FBS and PPBS are important to achieve optimal glycemic control, but PPBS has a closer association with HbA_{1c} and better predictor for overall glycemic control compared to FBS, which is similar to the studies reported by Rosediani et al, Abrahamson et al and Monnier et al.[18,27,28]

Conclusion

The result suggests that correcting both will help to achieve a good glycemic control. Thus, if one aims at controlling plasma glucose not only in the fasting state but throughout the day to achieve better long-term metabolic control (HbA_{1c}) and minimize the risk of chronic diabetic complications, glucose monitoring cannot be limited to fasting or post prandial glucose monitoring but correcting glucose levels all throughout the day will result in a greater reduction of HbA_{1c}.

References:

1. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care, 2013; 36(Suppl 1):67-74.
2. Ghazanfari Z, Haghdoost AA, Alizadeh SM, Atapour J, Zolala F. A Comparison of HbA1c and Fasting Blood Sugar Tests in General Population. Int J Prev Med, 2010; 1(3):187–194.
3. Stratton M,Adler AL, Neil AW, Matthews DR, Manely SE, et al. Association of glycemia with macrovascular and microvascular complication of type 2 diabetes prospective observational study, BMJ 2000; 312:405-12.
4. Bouma M, Dekker JH, de Sonnaville JJ, van der Dose FE, de vries H, Kriegsman DM, et al. How valid is fasting plasma glucose as a parameter of glycemic control in non-insulin using patient with type 2 diabetes? Diabetes care, 1999; 22:904-7.
5. Feinglos MN, Tracker CH, English J, Bethel Ma, Lane JD. Modification of postprandial hyperglycemia with insulin lispro improves glucose control in patient with type 2 diabetes. Diabetes care, 1997; 20:1539-42.
6. Bastyl EJ, Stuart CA, Brodows RG, Schwartz S, Graf CJ, et al. Therapy focuses focused on lowering postprandial glucose, non fasting glucose, may be superior for lowering HbA1c. Diabetes care, 2002; 23:1336-41.
7. Glycosylated hemoglobin [Online]. 2007 August 16 [Cited on 2011 August 18] Available from http://en.wikipedia.org/wiki/Glycosylated_hemoglobin.
8. Genc, s, Omer, B., Aycan-Ustyol, E., Ince, N., Bal, F. and Gurdol, F, Evaluation of Turbidometric Inhibition Immunoassay (TINIA) and HPLC Methods for Glycated Haemoglobin Determination. J Clin Lab Anal,

2012; 26:481-485.
9. Standard of Medical Care in Diabetes 2007. American Diabetes Association, Diabetic Care, 2007; 30:S4-41.
10. American Association of Clinical Endocrinology Diabetes Care Plan Guidelines. Endocr Pract, 2011; 17(Suppl 2):6-7.
11. Rudy Bilous Richard Donnelly, Handbook of Diabetes, 4th edition. Blackwell Publishing Ltd, 2010.
12. Bonora E, Francesco C, Simonetta 1. Plasma glucose levels throughout the day and HbA1c interrelationships in type 2 diabetes: Implications for treatment and monitoring of metabolic control. Diabetes Care, 2001; 20:1822-1826.
13. Monnier L, Colette C. Contributions of fasting and postprandial glucose to hemoglobin A_1C. Endocr Pract, 2006 Jan-Feb; 12(Suppl 1):42-6.
14. S. W. Masram, M. V. Bimanpalli. Assessment of contribution of fasting and post meal plasma glucose to increased HbA1C in diabetes mellituscomparative study. Int J Biol Med Res, 2012;3(3):2020-4.
15. Riddle M1, Umpierrez G, DiGenio A, Zhou R, Rosenstock J. Contribution of basal and postprandial hyperglycemia over wide range of A_1C levels before and after treatment intensification in type 2 diabetes. Diabet Care, 2011 Dec; 34(12):2508-14.
16. Rosediani M, Azidah AK, Mafauzy M. Correlation between fasting plasma glucose, post prandial glucose and glycated haemoglobin and fructosamine. Med J Malaysia, 2006, Mar; 61(1):67- 71.
17. Antonio Ceriello, Stephen Colagiuri, John Gerich, Jaakko Tuomilehto. Guideline for management of post meal glucose. Rev Nutr Metab Cardiovasc Dis, 2008; 18:S17-33.
18. Rosediani M, Azidah AK, Mafauzy. Correlation between fasting plasma glucose, post prandial glucose and glycated haemoglobin and ructosamine. Med Ja Malaysia, 2006; 61(1):67-71.
19. Soonthornpun S, Rattarasarn C, Leelawattana R, Setasuban W. Postprandial plasma glucose: a good index of glycemic control in type 2 diabetic patients having near-normal fasting glucose levels. Diabetes Res Clin Pract, 1999; 46:23.27.
20. Verges B. The impact of regulation of postprandial glucose in practice. Diabetes Metab, 1999; 7(Suppl):22-25.
21. Bonora E, Calcaterra F, Lombardi S, Bonfante N, Formentini G, Bonadonna R, Muggeo M. Plasma glucose levels throughout the day and HbA1c interrelationships in type 2 diabetes: implications for treatment and monitoring of metabolic control. Diabetes Care, 200; 24:2023-029.
22. R. Peter, S. D. Luzio, G. Dunseath, V. Pauvaday, N. Mustafa, D. R. Owen. Relationship between HbA1c and indices of glucose tolerance derived from a standardized meal test in newly diagnosed. Diabetic Med, 2006; 23(9):990-95.
23. Goudswaard AN, Stolk RP, Zuithoff P, Rutten GE. Patient characteristics do not predict poor glycaemic control in type 2 diabetes patients treated in primary care. Eur J Epidemiol, 2004; 19(6):541-45.
24. Sikaris K. The correlation of hemoglobin A1c to blood glucose. J Diabetes Sci Technol, 2009; 3:429-38.
25. Ketema EB, Kibret KT. Correlation of fasting and postprandial plasma glucose with HbA1c in assessing glycemic control; systematic review and meta-analysis. Arch Public Health, 2015; 73:1-9.
26. Haghighatpanah M, Thunga G, Khare S, Mallayasamy. S. correlation of glycosylated Hb levels with fasting and postprandial glucose in south Indian type 2 diabetic patients. Int J Pharm Pharm Sci, 2016; 8(8):285-288.
27. Abrahamson MJ. Optimal glycemic control in type 2 diabetes mellitus: fasting and postprandial glucose in context. Arch Intern Med, 2004; 164:486-91.
28 Monnier L, Lapinski H, Colette C. Contributions of fasting and postprandial plasma glucose increments to the overall diurnal hyperglycemia of type 2 diabetic patients variations with increasing levels of HbA_{1c}. Diabetes Care, 2003; 26:881-85.