Sub-optimal postprandial blood glucose level in diabetics attending the outpatient clinic of a University Hospital

Daad H. Akbar, FRCP, FACP.

ABSTRACT

Objectives: To determine the frequency of diabetic patients who attained the optimal postprandial blood glucose level.

Methods: Cross-sectional study of type-2 diabetic patients being followed at the medical outpatient clinic of King Abdul-Aziz University Hospital, Jeddah, Kingdom of Saudi Arabia, from January 1999 to December 2001. Patients were classified according to postprandial blood glucose level into 3 categories; group-1 (<9mmol/l), group-2 (9.1-10 mmol/l), group-3 (>10 mmol/l). Other data such as age, sex, duration of diabetes, presence of hypertension, hyperlipidemia, smoking, obesity, ischemic heart disease was recorded as well as mortality.

Results: A total of 443 patients were studied with mean age of 55 years and equal male to female ratio. The mean 2-hour postprandial blood glucose level was 14 mmol/l. The majority of patients were in group-3 (71%), while group-1 was 22% and group-2 was 7%. Patients with high 2-hour postprandial blood glucose (group-3) have a higher prevalence of hypertension [120/315 (38%) versus 31/97 (32%) p=0.01], hyperlipidemia [72/315 (23%) versus 13/97 (13%) p=0.02], obesity [79/315 (25%) versus 18/97 (19%) p=0.04], ischemic heart disease [72/315 (23%) versus 16/97 (17%) p=0.04] and mortality [35/315 (11%) versus 8/97 (8%) p=0.06] compared to those with controlled level (group-1).

Conclusion: A low frequency of diabetics attained the optimal 2-hour postprandial blood glucose level. Action should be taken on this crucial issue for the optimal management of diabetes.

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Diabetes mellitus has recently been classified as a major independent risk factor for the development of coronary heart disease.[1] Patients with diabetes have increased risk of cardiovascular morbidity and mortality. Diabetic patients without previous myocardial infarction have outcomes similar to non-diabetic patients who have had previous myocardial infarction.[2] The importance of postprandial blood glucose is evident in the literature. Postprandial hyperglycemia (PPH) has been associated with increased risk of microvascular and macrovascular complications.[3-7] The Diabetes Intervention Study had showed that PPH was an independent risk factor for myocardial infarction and cardiac death.[8] We aim in our study to determine the frequency of diabetic patients, attending the outpatient medical clinic of King Abdul-Aziz University Hospital, Jeddah, Kingdom of Saudi Arabia (KSA), with optimal postprandial blood glucose level.

Methods. A cross-sectional study in which type-2 diabetic patients being followed in the outpatient medical clinic of King Abdul-Aziz University Hospital, Jeddah, KSA, from January 1999 to December 2001 were studied. The mean level of the last 2 fasting and 2-hours postprandial blood glucose (which were

From the Department of Medicine, King Abdul-Aziz University Hospital, Jeddah, *Kingdom of Saudi Arabia*.

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Address correspondence and reprint request to: Dr. Daad H. Akbar, Associate Professor/Consultant Physician, PO Box 115652, Jeddah 21381, *Kingdom of Saudi Arabia*. Tel. +966 55604854. Fax. +966 (2) 6944857. E-mail: daadakb@yahoo.com

measured on an average of 6-12 weeks apart) was recorded. According to the expert committee report of the American Diabetes Association in 1999,[9] the goal 2-hour postprandial blood glucose has to be 160 mg/dl (8.8 mmol/l) and action should be taken if it reaches 180 mg/dl (10 mmol/l); for fasting it is 120mg/dl (6.6 mmol/l) with action to be taken if it reaches 140 mg/dl (7.7 mmol/l). In 2002 a recommendation for a wider range for fasting 90-130 mg/dl (5-7 mmol/l)] was proposed and action suggested if it reached >150 mg/dl (8.3 mmol/l) and for bed time glucose it was 110-150 mg/dl (6-8.3mmol/l) and >180mg/dl (10 mmol/l).[10] As we are using mmol/l unit for the measurement of plasma glucose in our hospital we classify the patients according to the 2-hours postprandial blood glucose level into 3-categories; goal <9 mmol/l, border line 9.1-10 mmol/l, poor >10 mmol/l. while for fasting; goal <7 mmol/l, borderline 7.1-8 mmol/l, poor >8 mmol/l. The following data was also collected from the study group; age, sex, body mass index (BMI), duration of diabetes, type of treatment (diet, oral hypoglycemic agents, insulin or combined), presence of hypertension (defined as blood pressure >140/90 mm Hg or if the patient is known hypertensive), hyperlipidemia (defined as low density lipoprotein (LDL) >2.6 mmol/l, high density lipoprotein (HDL) <1.1 mmol/l, triglyceride >1.7 mmol/l), history of smoking, history of ischemic heart disease (assessed by patient's history or changes on electrophysiological studies), and mortality. The frequency of diabetic patients in each group was calculated, and the relations between them and cardiovascular risk factors and mortality were determined. Statistical analysis was carried out using the Statistical Package for Social Sciences 9.1 software. Values as mean ± standard deviation were given for quantitative data and frequency for categorical variables. Chi-square was used to analyze group differences for categorical variables. For continuous variables t- test was used when comparing 2 groups. *P*-value <0.05 was considered significant.

Results. A total of 443 patients were enrolled in the study. Out of which 217 (49%) were males. The mean age was 54.8 ± 16.2 years and the mean BMI 25.5 ± 3.6 m^2/kg. Two hundred and seventy (61% were on oral hypoglycemic agents, 133/443 (30%) on insulin, 27/443 (6%) on diet and 13/443 (3%) on combined treatment. The mean fasting blood glucose for the study group was 9.7 ± 3.2 mmol/l while for 2-hour postprandial blood glucose it was 13.75 ± 5.5 mmol/l. A low frequency of patients attained the goal for fasting and 2-hour postprandial blood glucose level and most of them lie in the poor control group (**Table 1**). No statistically significant difference was detected between the goal group and the poor control group of 2-hour postprandial blood glucose regarding age or sex distribution while patients with poor control are more likely to have associated cardiovascular risk factors, ischemic heart disease and poor outcome (**Table 2**). Patients with poor 2-hour postprandial blood glucose control are also more likely to have poor fasting blood glucose control compared to goal control; 75/97 (77%) of patients with goal 2-hour postprandial blood glucose also had goal fasting blood glucose compared to 17/97 (18%) with poor fasting blood glucose (p<0.001), while 202/315 (64%) of patients with poor 2-hour postprandial blood glucose had poor fasting blood glucose versus 76/315 (24%) who have goal fasting blood glucose (p<0.001).

Table 1 - Frequency of fasting and postprandial blood glucose in different groups.

Fasting blood glucose	Group 1 (<7mmol/l) n (%)	Group 2 (7.1-8 mmol/l) n (%)	Group 3 (>8 mmol/l) n (%)
	168 (38)	49 (11)	226 (51)
Postprandial blood glucose	**Group 1 (<9mmol/l)**	**Group 2 (9.1-10 mmol/l)**	**Group 3 (>10 mmol/l)**
	97 (22)	31 (7)	315 (71)

Table 2 - Relationship between postprandial hyperglycemia (Group 1 and Group 3) and different variables.

Variable	Group 1 (N=97)	Group 3 (N=315)	*p*-value (CC)
Age in years (mean ± SD)	54±16	53±15	0.6
Male:female ratio	1:1.1	1:1.1	0.9
Duration of diabetes (in years)	8±6	9.5±8	0.1
Hypertension n (%)	31 (32)	120 (38)	0.01
Hyperlipidemia n (%)	13 (13)	72 (23)	0.02
Obesity (BMI>27 m^2/kg) n (%)	18 (19)	79 (25)	0.04
Smoking n (%)	34 (35)	110 (35)	0.4
Ischemic heart disease n (%)	16 (17)	72 (23)	0.01
Mortality n (%)	8 (8)	8 (8)	0.06

SD - standard deviation; BMI - body mass index

Discussion. Despite the significant advances in the management of coronary heart disease and the decline in mortality of cardiovascular disease in the general population by 36% in men and 27% in women over the last decade, diabetic patients continue to have a high incidence of coronary heart disease and poor clinical outcome. The decline in mortality in diabetics was only 13% in diabetic men, and it increased by 23% in diabetic women.[11,12] Epidemiological and clinical evidence is mounting on the important contribution of postprandial blood glucose excursions to overall glycemic control and the association between postprandial hyperglycemia and many of the major micro- and macrovascular complications of diabetes, including retinopathy, nephropathy, and cardiovascular disease.[13-17] The risk of cardiovascular disease and all-cause mortality increases with increasing postprandial blood glucose values,[18-21] in addition, as indicated by the Oslo study, PPH was a predictor of fatal stroke in diabetics and the risk

creased by 13% for each 18 mg/dl elevation in stprandial blood glucose level.[22] Another study cumented that PPH is an independent risk factor for ripheral vascular disease.[23] Recent reports suggested association between PPH and intellectual function in derly Alzheimer's patients.[24] Our study showed a gher prevalence of ischemic heart disease and higher ortality in patients with high PPH compared to those ith low levels. Several mechanisms had been proposed r the increased risk of complications that are seen in tients with PPH. The PPH is associated with perinsulinemia and higher plasma level of triglyceride, ylomicrons, chylomicron remnants and free fatty ids. Hyperinsulinemia has been shown to be a risk ctor for cardiovascular events. The Paris prospective udy found that postprandial hyperinsulinemia was a edictor for fatal cardiovascular disease.[25] Similarly, e Helsinki Policeman Study revealed an independent sociation between fatal and nonfatal cardiovascular vents and postprandial hyperinsulinemia.[26] High ncentration of free fatty acid is associated with ndothelial dysfunction.[27] High level of triglycerides is sociated with low levels of HDL and preponderance of n dense LDL particles. Studies have shown that ypertriglyceridemia predicts the development of ronary artery disease and is associated with increased rotid artery atherosclerosis.[28,29] Excessive postprandial lood glucose stimulates production of free radicals hich are also another factor involved in the herosclerotic process.[30] Postprandial hyperglycemia as been associated with transient hypercoagulability sulting from increased thrombin production and creased fibrinogen breakdown.[31] Goal postprandial lood glucose level (<9 mmol/l) has been found in only 2% of our diabetic patients, while the majority (71%) ad levels more than 10 mmol/l. Poor glycemic control a global problem. Harris et al[32] reported a rate of poor lycemic control (hemoglobin A1c >8%) in 50% of on-Hispanic black women and 45% in Mexican males. imilar results were reported by Schiel et al from ermany.[33] While Azab[34] reported poor fasting blood lucose control (>10 mmol/l) in 49% of diabetic patients ttending Primary Health Care Centers in Riyadh, KSA, is poor glycemic control could be a result of poor on. ance either due to the patients being unable to fford to buy the medications, lack of knowledge about e importance of good glycemic control or poor mpliance with long time medications. Efforts should e carried out for better patients' education through ifferent media; supply of medication and proper follow p.

Clearly PPH is strongly associated with ardiovascular risk factors such as hypertension, yperlipidemia, and obesity. Epidemiological studies uggest that postprandial rather than fasting glucose evels may better predict individuals at increased risk of eveloping complications associated with yperglycemia.[35,36] Avignon and colleagues[37] showed at postprandial glucose levels were better predictors of overall glycemic control and were correlated better with A1c than fasting glucose levels. For patients with diabetes, postprandial blood glucose excursions can contribute 20-40% to the elevation of A1c above baseline. The United Kingdom Prospective Diabetes Study Group has clearly demonstrated that reduction of A1c is significantly associated with reduction in the risk of microvascular complications.[14] The full clinical significance of chronic hyperglycemia is well documented in studies that show the many complications associated with continuously increased blood glucose levels. The contribution of postprandial hyperglycemia to these complications is now emerging from studies that indicate that there may be effects of acute hyperglycemia on the development of retinopathy, neuropathy, nephropathy, and especially cardiovascular disease. Postprandial hyperglycemia is a neglected cardiovascular risk factor in diabetics. Based on evidence of the importance of postprandial blood glucose excursions on evaluation of hyperglycemia, the monitoring of postprandial blood glucose excursions and treatment of postprandial hyperglycemia, are critical to the optimal management of diabetes.

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