Research Article

Assessment of long term glycaemic control (HbA1c) and its correlation with biochemical and other parameters in patients with type 2 diabetes mellitus in an urban community setting

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Abstract

Background: Presence of diabetes changes one's life image and creates demand for treatment. Long-term vascular complications are a major cause of morbidity and mortality in patients with diabetes mellitus. Patients with type 2 diabetes often show an unusual biochemical profile. There is a must need for constant screening for this life threatening complications by regular testing of biochemical and other parameters. The core issue is achieving long term glycemic control with objective to reduce fear of debilitating complications.

Objective: To assess long term glycemic control (past 3 months) by HbA1c in type 2 diabetes mellitus patients in an urban community setting. To study correlation and linear regression between biochemical tests (FBS, PPBS, lipid profile etc.) and other parameters (ECG, fundoscopy) with glycosylated hemoglobin.

Material and Methods: It is a community based cross sectional study. 183 study subjects selected from urban community who were already diagnosed of type II diabetes mellitus with active treatment for more than 6 months. Questionnaire administered with biochemical parameters CBC, urine R and M, FBS, PPBS, last reported fasting and postprandial blood sugar, lipid profile, BUN, S. creatinine and ECG, fundoscopy (R/O retinopathy). Glycosylated hemoglobin was done by standardized HPLC technique.

Result: Out of 183 study subjects, 140 (i.e. 76.5%) subjects have fair glycaemic control and 40 (23.5%) have poor glycaemic control. 33 subjects (55%) have frequency of testing for blood sugar more than 6 months had poor glycemic control and 113 subjects (91.9%) have good glycemic control with within 6 months testing for blood sugar. Out of 183 subjects, 40 (33.1%) with poor glycemic control had last reported fasting sugar more than 110 mg% and 43 (31.6%) subjects had poor glycemic control with last reported post prandial glycemic control more than 140 mg%.

Conclusion: The study shows that there is strong association between some biochemical parameters and poor glycemic control.

KEY WORDS: Type II diabetes mellitus, biochemical parameters, HbA1c

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Introduction

Diabetes mellitus is a chronic metabolic disease characterized by disorder in the metabolism of carbohydrates, lipids, and amino acids either as a result of decreased insulin secretion or due to reduction to insulin sensitivity of the body cells, it is a disease that acquires epidemic form as its prevalence has five folded during last 15 years and constitutes one of the major threats to human health in 21st century.[1-5]

Diabetes-related distress refers to the emotional burden that may be an aspect of managing a chronic illness, and can be found in both those with diabetes and their caregivers.[6]

The importance of protecting the body from hyperglycemia cannot be overstated; the direct and indirect effects on the human vascular tree are the major source of morbidity and mortality in both type 1 and type 2 diabetes. Generally, the injurious effects of hyperglycemia are separated into macrovascular complications (coronary artery disease, peripheral arterial disease, and stroke) and microvascular complications (diabetic nephropathy, neuropathy, and retinopathy).[7]

Patients with type 2 diabetes are at greater risk of developing vascular diseases because of lipid changes due to resistance to insulin, and hyperglycemia, which include decreased high density lipoprotein, increased more small dense low density lipoprotein and high triglycerides.[8] HbA1c is considered the gold standard of long-term glycemic control and is recommended as a routine test for every diabetic patient.[9]

The present study has aim at assessment of long term glycemic control (HbA1c) among the subjects with type 2 diabetes mellitus along with correlation of HbA1c with biochemical parameters and other variables responsible for complications of diabetes mellitus.

Materials and Methods

The study is a community based cross sectional study aimed at primarily assessing glycemic control over the last 3 months and its correlation with biochemical and other parameters. The study was conducted in urban community under urban health centre field practice area of Mumbai involving all class IV government employees quarters.

Study subjects included were already diagnosed case of type 2 diabetes mellitus and on active therapy for more than 6 months. First baseline survey was done and number of eligible subjects was identified. Total of 6865 individuals were screened for diabetes and its treatment status and 183 subjects with type 2 diabetes and more than 18 years of age were eligible for the study.

A semi-structured questionnaire was taken to collect the sociodemographic profile and the details of the diabetes and its treatment. The details regarding the diabetes included the duration of the condition, duration of treatment, type of treatment being received, complications due to diabetes, family history of diabetes, and body mass index (BMI). The level of diabetes control was assessed using the HbA1c levels, fasting blood glucose, and postprandial blood glucose. Actual questionnaire administration and physical examination was followed by laboratory work up which was done in the health center attached to this colony by trained laboratory technicians.

Long term glycaemic control was assessed by estimating HbA1c (A1c fraction of hemoglobin) by high pressure liquid chromatography (HPLC) technique. This technique is considered as the gold standard in the estimation of HbA1c. HbA1c estimation was done by M/S Thyrocare Limited. This laboratory is a reputed highly specialized laboratory, which is equipped for high quality work.

The biochemical and other parameters checked along with glycosylated hemoglobin were CBC, urine R and M, FBS, PPBS, lipid profile, BUN, S. Creatinine, ECG, and fundoscopy to rule out retinopathy.

Analysis was carried out using the SPSS version 16.0. Descriptive statistics were carried out for different sociodemographic- and diabetes-related parameters. Pearson's c^2, OR and 95% CI, correlation coefficient, ANOVA and binary logistic regression was used for analysis among the variables. The level of significance for all the statistical tests was kept at $p<0.05$.

Result

As per data presented in Figure 1, among 183 study participants 51% of respondents had poor glycemic control (>7 HbA1c) and 49% had fair glycemic control (≤7 HbA1c).

Gender distribution among the study participants showed 51% cases were females and 49% were males. Age wise distribution showed 74 participants were <50 years age and remaining 109 were >50 years age. Among marital status wise distribution 22 study participants were either unmarried or widow and rest 161 were married. Nuclear type of family was seen among 157 study participants and 26 had joint family. Duration of diabetes was ≥6 years among 54 participants and ≤ 5 years diabetes duration was seen among 129 study participants. Frequency for testing diabetes for control was seen < 6 months among 123 participants rest 60 participants

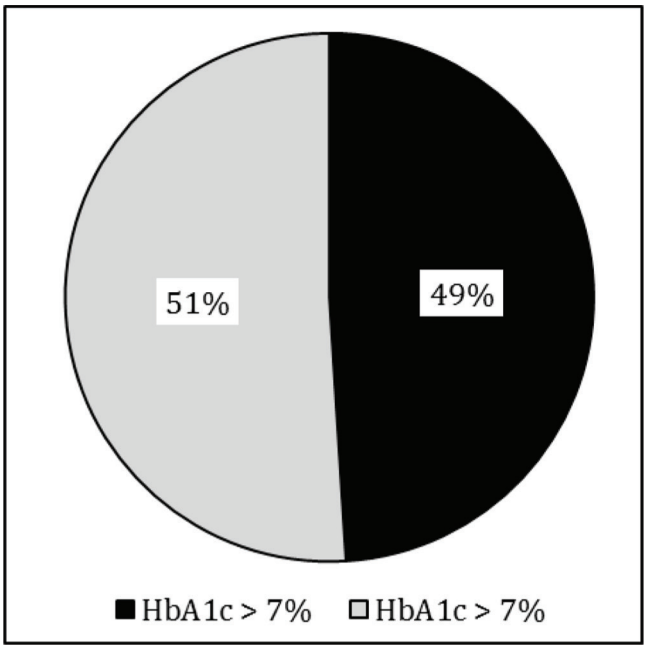

Figure 1: Glycemic control status among study participants

Table 1: Comparison of demographic and socio-economic profiles between those having poor and fair glycemic control

Demographic variables	Glycemic control		Chi square	Significance, p
	Fair (%)	Poor (%)		
Gender				
Male	72 (80.0)	18 (20.0)	1.20	NS
Female	68 (73.1)	25 (26.9)	(0.73–2.93)	
Age <50 years	56 (75.7)	18 (24.3)	0.047	NS
≥50 years	84 (77.1)	25 (22.9)	(0.49 – 1.55)	
Marital status				
Married	122 (75.8)	39 (24.2)	0.39	NS
Unmarried and widowed	18 (81.8)	4 (18.2)	(0.22–2.17)	
Type of family				
Joint	18 (69.2)	8 (30.8)	0.89	NS
Nuclear	122 (77.7)	35 (22.3)	(0.62 – 3.86)	
Diabetes Duration(years)				
≤ 5	96 (74.4)	33 (25.6)	1.05	NS
≥ 6	44 (81.5)	10 (19.5)	(0.30 – 1.17)	
Frequency of testing				
< 6 months	113 (91.9)	10 (8.1)	49.28	<0.0001
≥ 6 months	27 (45.0)	33 (55.0)	(6.06 – 31.44)	

had frequency for testing diabetes ≥ 6 months duration. Comparison of the demographic and socioeconomic variables along with fair and poor glycemic control showed that gender, age, type of family, marital status, and diabetes duration were not significant. Frequency of blood sugar testing was very highly significant with poor or fair glycemic control (p<0.0001) (Table 1).

Comparison of biochemical variants with glycemic control showed that study subjects with last reporting fasting blood sugar more than 110 mg% had significantly poor glycemic control compared to those with less than 110 mg% last reporting fasting blood sugar (Chi square 18.160, p<0.0001). Similarly, last reporting post prandial blood sugar of more than 140 mg% had poor glycemic control as compared to last reporting post prandial blood sugar (Chi square 19.425, p<0.0001). Poor glycemic control was seen among the study subjects with urine sugar (fasting) 1+ and 2+ as compared NIL report in urine sugar (fasting) similar finding was seen with post prandial urine sugar report. Among lipid profile LDL/HDL ratio, poor glycemic control was observed among ratio of ≥3.5 (Chi square 12.197, p<0.0001). Both fasting (≥ 110 mg%) and post prandial blood sugar (≥ 140 mg%) were highly significant with poor glycemic control (Table 2).

Pairs of quantitative variables as shown in this table were analyzed for correlation using Pearsons R and Spearman's correlation was used for qualitative variables. All the variables were found to highly significant with glycosylated hemoglobin. Diastolic blood pressure (R=0.191) and systolic blood pressure (R=0.172) were highly significant with glycosylated hemoglobin. Among qualitative variables ECG changes for old myocardial infarction (0.331) and diabetic retinopathy (0.412) were very highly significant glycosylated hemoglobin. Frequency of testing for blood sugar with more than 6 months was highly significant with glycosylated hemoglobin (Table 3).

Binary logistic regression analysis was done to rule out the possible effect of confounding and interaction in univariate analysis as shown in Table 4. Duration of diabetes, frequency of testing for diabetes, urine sugar fasting, and diabetic retinopathy were found to be statistically significant with poor glycemic control among the study participants.

Discussion

In the present community based cross-sectional study, glycemic control status among the known diabetic subjects was evaluated. Fifty one percent of diabetic subjects were having fair glycemic control and 49% had poor glycemic control on the basis of glycosylated hemoglobin (HbA1c) value estimation. Gender difference, age, marital status, and type of family were not significantly associated with poor glycemic control. Frequency of testing for blood sugar, last reported blood sugar fasting, and post prandial was significantly associated with poor glycemic control. Both changes in ECG and presence of diabetic retinopathy were highly associated with poor glycemic control among the known diabetic subjects in the study.

Frequency of testing for diabetes mellitus more than 6 months was found to be significant with poor glycemic control in two different studies, Evans et al.[10] concluded that regular self monitoring of blood glucose concentration is associated with improved glycaemic control in both types of diabetes and Harris et al.[11] concluded that, frequency of self monitoring of blood glucose associated with normal HbA1c values in insulin treated type 2 diabetes patients. Last reported

Table 2: Comparison of psychological variants between those having poor and fair glycemic control

Biochemical variants	Glycemic control		Chi square	Significance, p
	Fair (%)	Poor (%)		
Last reported blood sugar (F)				
<110 mg%	121 (86.4)	19 (13.6)	18.160	<0.0001
≥ 110 mg%	19 (44.2)	24 (55.8)		
Last reported blood sugar (PP)				
<140 mg%	47 (100)	0	19.425	<0.0001
≥ 140 mg%	93 (68.4)	43 (31.6)		
Urine sugar (F)				
NIL	123 (90.4)	13 (9.6)	56.459	<0.0001
1+	9 (56.3)	7 (43.8)		
2+	8 (25.8)	23 (74.2)		
Urine sugar (PP)				
NIL	73(94.8)	4 (5.2)	37.083	<0.0001
1+	14(93.3)	1 (6.7)		
2+	53(58.2)	38 (41.8)		
LDL-HDL ratio				
<3.5	126 (81.3)	29 (18.7)	12.197	<0.0001
≥3.5	14 (50.0)	14 (50.0)		
Blood sugar (F)				
<110 mg%	57 (93.4)	49 (6.6)	14.067	<0.0001
≥ 110 mg%	83 (68.0)	39 (32.0)		
Blood sugar (PP)				
<140 mg%	47 (100)	0 (0)	19.425	<0.0001
≥ 140 mg%	93 (68.4)	43 (31.6)		

Table 3: Bivariate correlation in between quantitative variables

Pair of variables (*n* = 183)	Pearson correlation coefficient (R)	Significance
Last reported blood sugar value (F) and Hba1c level	0.558	< 0.0001 (VHS)
Last reported blood sugar value (PP) and HbA1c level	0.664	< 0.0001 (VHS)
Systolic BP and HbA1c level	0.172	0.020 (HS)
Diastolic BP and HbA1c level	0.191	0.010 (HS)
Blood sugar fasting and HbA1c level	0.714	<0.0001 (VHS)
Blood sugar PP and HbA1c level	0.795	<0.0001 (VHS)
ECG changes and HbA1c	0.331	0.0001 (VHS)
Diabetic Retinopathy and HbA1c	0.412	0.0001 (VHS)
Frequency of testing and HbA1c	0.519	0.0001 (VHS)

Table 4: showing Logistic regression analysis

Variable	Odds ratio	95% CI (OR)	Z Score	p value
Education	1.96	0.740 – 5.194	1.35	0.175
Duration of Diabetes	6.206	1.179 – 32.65	2.16	0.031*
Frequency of testing	1216.4	19.22 – 76957.4	3.36	0.001*
Urine sugar (F)	5.401	1.674 – 17.357	2.82	0.005*
Urine Sugar (PP)	1.437	0.515 – 4.009	0.69	0.488
Fasting Blood sugar	0.317	0.320 – 8.371	0.20	0.839
LDL-HDL ratio	3.631	0.460–28.78	1.22	0.222
ECG changes	1.012	0.240–4.302	0.02	0.987
Diabetic retinopathy	14.10	2.532–78.401	3.02	0.003*

fasting and post prandial blood sugar significantly associated with high HbA1c values and denotes poor glycemic control if deranged over last few months. Similar finding was observed by Koenig et al.[12] who concluded in their study that HbA1c concentration appears to reflect the mean blood sugar concentration best over previous weeks or months. Both elevated fasting and post prandial blood sugar were significantly associated with elevated HbA1c among the study subjects which indicates poor glycemic control. Garber et al.[13] and Kuusisto et al.[14] in their study noticed significant association between HbA1c level and both fasting and post prandial blood glucose levels. ECG changes and diabetic retinopathy was seen significantly more among raised HbA1c study subjects as compared to those with normal HbA1c levels. Similar finding was noted in a study where HbA1c levels correlated significantly with subjects having past history of myocardial infarction.[14] Subjects with poor glycemic control had altered LDL/HDL ratio in the study. Diabetic subjects with positive glucosuria both fasting and post prandial were associated with raised HbA1c. Similar finding was seen in a study and suggested urine glucose self-monitoring is a cheap and effective method to determine the quality of glucose control (Table 2).[15]

Bivariate correlation both quantitative and qualitative variables with HbA1c showed high significance. Systolic and diastolic blood pressure was significantly correlated with glycosylated hemoglobin. Foo et al.[16] examined the association of hemoglobin A1c (HbA1c) and systolic blood pressure (SBP) variability, found similar finding with significant higher mean of HbA1c and systolic blood pressure. Diabetic retinopathy was significantly more among the diabetic subjects with poor glycemic control as compared to fair glycemic control in the present study. Similar finding was quoted by Cho et al.[17] who studied optimal cut off levels of HbA1c for diabetic retinopathy and concluded that HbA1c levels of 6.5–6.8 are optimal HbA1c cutoff for detecting any diabetic retinopathy. In another study done by Raman et al.[18] evaluated the role of glycosylated hemoglobin (HbA1c) on the occurrence of sight threatening diabetic retinopathy and concluded that HbA1c value of more than 8.0% was significantly related with STDR (Table 3).

Duration of diabetes mellitus with more than 6 years was found significant among the study subjects with poor glycemic control suggest that regular monitoring for glycemic control is must. Similar finding was also observed in a study by Moss et al.[17] who studied the association of glycemia with cause-specific mortality in a diabetic population. Study concluded that after controlling for other risk factors in proportional hazards models and considering underlying cause of death, glycosylated hemoglobin was significantly associated with mortality from diabetes along with duration of disease. Logistic regression analysis interpreted that urine sugar fasting, diabetes duration, frequency of testing and diabetic retinopathy was highly significantly associated with raised HbA1c among study subjects which rule out the possible effect of confounding and interaction in univariate analysis (Table 4).

The strength of the present study is measurement of glycosylated hemoglobin (HbA1c) and is helpful to identify actual glycemic control (average of 3 months blood sugar) among the known diabetic subjects as compared to fasting and post prandial blood sugar. Regular measurement of biochemical investigation in the diabetic subjects will rule out early detection of any complication related to diabetes mellitus. The limitation of the study is as the present study is a cross sectional study to find out glycemic control and risk factors among known diabetic subjects conducted in community under urban health centre of teaching hospital, a prospective study with three monthly measurements of HbA1c should be carried out in a large study base. This would enable better understanding role of risk factors and their association with glycaemic control.

Conclusion

Among 183 study subjects, 94 (51%) had fair glycaemic control (HbA1c ≤ 7%). Duration of diabetes mellitus was associated with poor glycaemic control in univariate analysis. Frequency of testing was one factor, which was strongly associated with glycaemic control. Both last reported (fasting and post prandial) blood sugar levels were significantly associated with glycaemic control. Urine sugar (fasting and post prandial) and blood sugar (fasting and post prandial) showed very strong association with glycaemic control. Amongst the lipid profile tests, low density lipoprotein and LDL–HDL ratio were significantly associated with glycaemic control. Both ECG changes as well as diabetic retinopathy changes were significantly associated with glycaemic control. Logistic regression analysis showed that duration of diabetes, frequency of testing, urine sugar (fasting) and diabetic retinopathy were independent risk factors for poor glycaemic control.

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