

Original Research Article

Association between glycemic control and serum fibrinogen levels in type 2 diabetes mellitus patients

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ABSTRACT

Background: Poor glycemic control has been reported to be associated with increased vascular complications in diabetes mellitus (DM) patients. High fibrinogen level has been described as an independent risk factor for cardiovascular diseases. High fibrinogen has been suggested to be involved in the excess rate of cardiovascular diseases in patients with type 2 DM. The present study was undertaken to find correlation between glycemic control and plasma fibrinogen level in patients with type 2 DM.

Methods: Three hundred ten patients aged ≥ 30 years of either sex were included in this cross sectional study. Estimation of glycated haemoglobin (HbA1c), serum fibrinogen, serum total cholesterol (TC), serum triglycerides (TG), serum high density lipoprotein (HDL) cholesterol, and serum low density lipoprotein (LDL) cholesterol was done. Categorical and continuous variables were tested using Chi-Square test/Fisher's exact test and unpaired 't' test respectively. Pearson's correlation was used to study correlation between serum fibrinogen levels and HbA1c, Body mass index (BMI), TC, LDL cholesterol, HDL cholesterol, and TG.

Results: Mean serum fibrinogen levels were significantly higher in DM patients whose HbA1c, LDL cholesterol and TG levels were higher. Correlation between serum fibrinogen was 0.59, and 0.45 with HbA1c, and BMI respectively. Multivariate step-wise regression analysis showed higher HbA1c and higher BMI were the independent and significant predictors of higher serum fibrinogen levels. HbA1c was the stronger predictor of serum fibrinogen than BMI.

Conclusions: Fibrinogen levels were independently associated with HbA1c value in patients with type 2 DM.

Keywords: Glycated haemoglobin, Serum fibrinogen, Serum total cholesterol, Serum triglycerides, Serum high density lipoprotein cholesterol, Serum low density lipoprotein cholesterol

INTRODUCTION

Diabetes mellitus (DM) is defined as "a chronic disease caused by inherited and/or acquired deficiency in production of insulin by the pancreas, or by the ineffectiveness of the insulin produced (insulin resistance). Patients with type 2 DM have been reported

to be at increased risk of developing cardiovascular related diseases such as myocardial infarction, stroke, and atherothrombosis. Many studies elucidated that DM affects vascular integrity by its effect on endothelium, smooth muscle function, as well as propensity to thrombosis, in addition to increased level of procoagulant factors and decreased fibrinolytic activity.^{1,2} Poor

glycemic control has been reported to be associated with increased vascular complications in diabetics.³ Fibrinogen is the major coagulation protein in the blood from which fibrin clot is formed. It is an important determinant of plasma viscosity, platelet aggregation and thrombus formation; also it is an acute-phase reactant that increases in inflammatory states.^{2,4,5} High fibrinogen level has been described as an independent risk factor for cardiovascular diseases.^{6,7} It has been suggested to be involved in the excess rate of cardiovascular diseases in patients with type 2 DM.⁸ Fibrinogen, itself is determined by several modifiable and non-modifiable determinants like age, sex, smoking, body mass index (BMI), hypertension, alcoholism, glycemic control and chronic kidney disease.^{9,10}

The primary objective of the present study was to find correlation between glycemic control and plasma fibrinogen level in patients with type 2 DM whereas the secondary objectives were to find the correlation between serum fibrinogen and other parameters like age, gender, duration of DM, BMI and hypertension.^{2,3}

METHODS

This cross sectional study was conducted between May 2015 and July 2017. After approval from the scientific advisory committee and institutional ethics committee, written informed consent was obtained from all patients.

Three hundred ten patients aged ≥ 30 years of either sex having type 2 DM who attended medicine outpatient department, DM outpatient department or admitted in Poona Hospital and Research Centre, Pune were included. Patients with known diagnosis of type-1 DM, patients on lipid lowering drugs, patients with functional thyroid disorder, chronic renal failure, nephrotic syndrome, liver disease, patients with coronary artery disease or presenting with acute coronary syndrome, ischemic stroke in last one year, patients with malignancy, acute/chronic infection patients, chronic alcoholic, smokers, familial hypercholesterolemic syndrome, females who were pregnant or on oral contraceptives or on hormone replacement therapy were excluded from this study.

Estimation of glycated haemoglobin (HbA1c), serum fibrinogen, serum total cholesterol (TC), serum triglycerides (TG), serum high density lipoprotein (HDL) cholesterol, and serum low density lipoprotein (LDL) cholesterol was done.

Expected values of TC, HDL cholesterol, LDL cholesterol, TG as per National cholesterol education program Adult treatment Plan III (NCEP ATP III) are as follows:¹¹

TC (mg/dL)

- Desirable-<200,

- Borderline high-200-239,
- High- ≥ 240 .

HDL cholesterol (mg/dL)

- <40 mg/dl-Low,
- >60 mg/dl-High.

LDL cholesterol (mg/dL)

- <100-Optimal,
- 100-129-Near optimal/above optimal,
- 130-159-Borderline high,
- 160-189-High,
- >190-Very high.

TG (mg/dL)

- Normal-<150,
- Borderline high-150-199,
- High-200-499,
- Very high- ≥ 500 .

American diabetes association (ADA) goal for optimal blood glucose control was used as standard reference for the present study (≤ 7 good control, >7 poor control).¹²

On the basis of a previously published study, a sample size of 310 patients was calculated by a formula with 80 % power and 5 % probability of Type I error to reject null hypothesis.^{13,14}

Data collected were entered in Excel 2007 and analysis of data was done using Statistical package for social sciences (SPSS) version 21, IBM, USA. The data on categorical variables is shown as n (% of cases) and data on continuous variables is shown as mean \pm standard deviation (SD). The inter-group statistical significance of difference of categorical variables was tested using Chi-Square test or Fisher's exact test. The inter-group statistical significance of difference of means of continuous variables between two groups was tested using unpaired 't' test. Pearson's correlation was used to study correlation between serum fibrinogen levels and BMI, HbA1c, TC, LDL cholesterol, HDL cholesterol, and TG. The confidence limit for significance was fixed at 95% level with p-value < 0.05 .

RESULTS

The study included 198 male (63.9 %) and 112 female (36.1%) type 2 DM patients. Thirty-nine (12.6%), 113/310 (36.5%), 80/310 (25.8%) and 78/310 (25.1%) patients were between the age group of 30-49, 50-59, 60-69 and ≥ 70 years respectively. Mean age of the patients was 61 ± 10.9 years. Of 310 patients, 91 (29.4%), 189 (61.0%) and 30 (9.6%) had duration of DM between 1.0-9.0, 10.0-19.0, and ≥ 20.0 years respectively. Of 310 patients 237 (76.5%) had hypertension. Eighty-seven

(28.0%), 89 (28.7%), and 134 (43.2%) patients had BMI <23.0, 23.0 <25.0 and ≥25.0kg/m² respectively. Mean serum fibrinogen levels were 359.2, 352.9, 365.9, 359.1, 372.5 and 397.3mg/dL in 30-39, 40-49, 50-59, 60-69, 70-79.0 and ≥80 years age groups respectively which was not statistically significant. Mean serum fibrinogen levels were 371.1 and 354.5mg/dL in males and females respectively which was not statistically significant.

The mean ± standard deviation of HbA1c of entire study group was 8.3 % ± 1.4%. The mean ± standard deviation of HbA1c in males and females was 8.2%±1.5% and 8.3%±1.4% respectively. Table 1 depicts HbA1c levels and gender.

Table 1: Distribution of patients according levels of HbA1c and gender.

HbA1c	Males (%)	Females (%)	Total (%)
<7.0	29 (14.6)	22(19.6)	51(16.5)
7.00-10	144(72.7)	78(69.6)	222(71.6)
>10.00	25(12.6)	12(10.7)	37(11.9)
Total	198(100.0)	112(100.0)	310(100.0)

Mean serum fibrinogen levels were 221.0, 289.1, 346.7 and 427.2 mg/dL in patients whose BMI was <18.5, 18.5 <23, 23 <25 and ≥25.0kg/m² respectively which was statistically significant (p=0.0001). Mean serum fibrinogen levels were 364.9, 366.5, and 356.9mg/dL in patients who had duration of DM between 1.0-9.0, 10.0-19.0, and ≥20.0 years respectively which was not statistically significant (p=0.937). Mean serum fibrinogen levels were 279.3, 356.3, and 536.5mg/dL in patients whose HbA1c was ≤7.0, 7.0-10.0 and >10.0 respectively which was statistically significant (p=0.0001). Mean serum fibrinogen levels were 380.1, and 360.5mg/dL in patients who had hypertension and didn't have hypertension respectively which was not statistically significant (p=0.279).

As depicted in Table 2, the distribution of mean serum fibrinogen did not differ significantly in patients whose TC levels ≥200mg/dL and whose TC levels were <200mg/dL. The distribution of mean serum fibrinogen did not differ significantly in patients whose HDL cholesterol levels ≥40mg/dL and whose HDL cholesterol levels were <40mg/dL. There was statistically significant difference in mean serum fibrinogen in patients whose LDL cholesterol levels ≥130mg/dL and whose LDL cholesterol levels were <130mg/dL. There was statistically significant difference in mean serum fibrinogen in patients whose TG levels ≥150mg/dL and whose TG levels were <150mg/dL

Correlation between serum fibrinogen with TC, LDL cholesterol, HDL cholesterol, TG, HbA1c, and BMI was 0.11, 0.20, -0.11, 0.11, 0.59, and 0.45 respectively. Multivariate step-wise regression analysis showed higher HbA1c and higher BMI were the independent and

significant predictors of higher serum fibrinogen levels (P-value<0.001 for both). Moreover, HbA1c was the stronger predictor of serum fibrinogen than BMI.

Table 2: Distribution of serum fibrinogen level with various parameters of lipid profile in diabetics.

Lipid Profile	Serum Fibrinogen in mg/dl (SD)	P-value
Total Cholesterol (mg/dl)		
< 200	360.6±128.1	0.410
≥ 200	374.0±146.8	
LDL Cholesterol (mg/dl)		
< 130	350.4±121.1	0.003
≥ 130	401.0±157.9	
HDL Cholesterol (mg/dl)		
<40	374.3±135.5	0.303
≥ 40	358.3±133.8	
Triglycerides (mg/dl)		
< 150	349.4±128.6	0.018
≥ 150	385.7±139.9	

DISCUSSION

The study was conducted in 310 type 2 DM patients to find correlation between serum fibrinogen and glycemic control and other parameters like age, sex, BMI, duration of diabetes and hypertension.

The mean ± standard deviation of age of the entire study group was 61.0±10.9 years. Mahendra et al, Dhawale et al, and Mohan et al reported mean age of patients as 59.9±7.9, 48.0±15.0, and 53.8±10.4 respectively.¹⁵⁻¹⁷

In the present study serum fibrinogen did not show significant correlation with age (P-value>0.05). The studies conducted by Jain et al, Bembde, Saini et al and Bruno et al reported that serum fibrinogen had a significant correlation with age.^{10,18-20} They reported that mean serum fibrinogen levels increased with increase in age. In the present study mean serum fibrinogen level in males (371.1±139.5) was higher than in females (354.5±125.2) but this difference was not statistically significant. Similar observation was made in some other studies.^{10,18,19} In the present study the serum fibrinogen level did not show significant correlation with duration of DM (P-value >0.05). This was in accordance with the studies conducted by Jain et al and Saini et al.^{10,19} In the present study serum fibrinogen level showed significant and positive correlation with BMI. Similar findings were reported by other studies.^{10,16,18,19} In the present research distribution of mean serum fibrinogen did not differ significantly between hypertensive and non-hypertensive cases studied (P-value>0.05). Similar findings were reported by Jain et al, Bembde and Saini et al.^{10,18,19} reported that fibrinogen levels were associated with hypertension (p<0.01).

The mean \pm standard deviation of HbA1c of entire study group was 8.3 \pm 1.4%. The mean \pm standard deviation of HbA1c in males and females was 8.2 \pm 1.5% and 8.3 \pm 1.4% respectively. These findings were similar to study conducted by Bembde in which the mean HbA1c value amongst type 2 DM cases was 8.5 \pm 1.69%.¹⁸ A1chieve study conducted in 20,554 Indian type 2 DM patients reported that the mean HbA1c was 9.2%.²¹ In the present study mean HbA1c level was lower as compared to A1chieve study. This difference from A1chieve study can be due to the small size of the patients in our study. Unnikrishnan et al reported younger age, duration of DM, and high triglyceride levels were associated with poor glycemic control.²²

The distribution of mean serum fibrinogen differed significantly across three groups of HbA1c in the present study (P-value<0.001). Mean serum fibrinogen level in patients with HbA1c <7% was 279.3 \pm 87.8mg/dl, whereas patients with HbA1c >10% had mean serum fibrinogen levels of 536.5 \pm 133.8mg/dl. The distribution of mean serum fibrinogen was significantly higher among patients with higher levels of HbA1c and showed significant and positive correlation with HbA1c levels (P-value<0.001). These findings are similar to other studies.^{16-20,23}

In the present study correlation between serum fibrinogen was 0.11, 0.20, -0.11, 0.11, 0.59, and 0.45 with TC, LDL cholesterol, HDL cholesterol, TG, HbA1c, and BMI respectively. Jain et al, reported fibrinogen levels were associated with BMI (r = 0.90), TG (r = 0.94), TC (r = 0.99), and HbA1c (r = 0.99) in DM patients in a significant manner.¹⁰ Dhawale et al, reported that mean fibrinogen level was 381.7 \pm 118.1 and 541.1 \pm 121.7 in type 2 DM patients whose TC was <200 and \geq 200mg/dL respectively.¹⁶ P value for relationship of TC with serum fibrinogen level was 0.05 whereas P value for relationship of TG, LDL and HDL with serum fibrinogen level were 0.08, 0.96 and 0.31 respectively. In the present study mean fibrinogen level was 360.6 \pm 128.1 and 374.0 \pm 146.8 in type 2 DM patient whose TC was <200 and \geq 200mg/dL respectively. P values for TC, LDL, HDL and TG were 0.410, 0.003, 0.303, and 0.108 respectively. The significant association of serum fibrinogen levels in our study with TC, LDL cholesterol, and TG with inverse association with HDL cholesterol were consistent with study conducted by Saini et al and Ernst et al.^{19,9} Bruno et al, reported that in multiple regression analysis HbA1c was associated with fibrinogen level.²⁰ Our findings are consistent with this study.

The correlation between glycemic control and fibrinogen levels could be due to glycosylated fibrinogen is less susceptible to plasmin degradation, relative insulin deficiency in DM patients resulting in differential protein synthesis i.e., 29% decrease in albumin synthesis and 50% increase in fibrinogen synthesis.²⁴

Fibrinogen has been well established to be a strong and independent cardiovascular risk factor in diabetics and in general population.²⁵⁻²⁹ Various mechanisms by which fibrinogen is found to promote atherosclerosis and thrombosis are hyperfibrinogenemia increases plasma viscosity, induces reversible red blood cell aggregation, binds to receptors on platelet membrane, causes platelet aggregation, forms fibrin and fibrinogen degradation products (FDPs) which in turn bind LDL and sequester more fibrinogen. Fibrinogen and FDPs stimulate smooth cell proliferation and migration. All these factors result in increased atherogenicity in patients of hyperfibrinogenemia i.e., DM and cause coronary artery disease. It has been demonstrated that elevated fibrinogen level is significantly associated with intima-media thickness and subclinical atherosclerosis.³⁰⁻³⁴ Previous studies reported that fibrinogen independently predicted future ischaemic stroke risk and increased incidence of hypertension.^{25,35,36}

Limitations of the study were that it was conducted in a single tertiary care hospital and represents only a small population. Patient's treatment history was not taken into consideration as both anti hypertensive and hypoglycemic drugs cause derangements in serum fibrinogen levels.

CONCLUSION

Mean serum fibrinogen levels were significantly higher in DM patients whose HbA1c, LDL cholesterol and TG levels were higher. Correlation between serum fibrinogen was 0.59, and 0.45 with HbA1c, and BMI respectively. Multivariate step-wise regression analysis showed higher HbA1c and higher BMI were the independent and significant predictors of higher serum fibrinogen levels HbA1c was the stronger predictor of serum fibrinogen than BMI.

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

REFERENCES

1. Zhao Y, Zhang J, Zhang J, Wu J. Diabetes mellitus is associated with shortened activated partial thromboplastin time and increased fibrinogen values. *PLoS One.* 2011;6:e16470.
2. Stec JJ, Silbershatz H, Tofler GH, Matheney TH, Sutherland P, Lipinska I, et al. Association of fibrinogen with cardiovascular risk factors and cardiovascular disease in the Framingham Offspring Population. *Circulation.* 2000;102:1634-8.
3. Kuusisto J, Mykkänen L, Pyörälä K, Laakso M. NIDDM and its metabolic control predict coronary heart disease in elderly subjects. *Diabetes.* 1994;43:960-7.

4. Kafle D, Shrestha P. Study of fibrinogen in patients with diabetes mellitus. *Nepal Med Coll J.* 2010;12:34-7.
5. Maple-Brown LJ, Cunningham J, Nandi N, Hodge A, O'Dea K. Fibrinogen and associated risk factors in a high-risk population: urban Indigenous Australians, the DRUID Study. *Cardiovascular Diabetology.* 2010;9:69.
6. Meade TW, Brozovic M, Chakrabarti RR, Haines AP, Imeson JD, Mellows S, et al. Haemostatic function and ischaemic heart disease: principal results of the Northwick Park Heart Study. *The Lancet.* 1986;328:533-7.
7. Kannel WB, Wolf PA, Castelli WP, D'Agostino RB. Fibrinogen and risk of cardiovascular disease. The Framingham Study. *JAMA.* 1987;258:1183-6.
8. Kannel WB, D'Agostino RB, Wilson PW, Belanger AJ, Gagnon DR. Diabetes, fibrinogen, and risk of cardiovascular disease: the Framingham experience. *Am Heart J.* 1990;120:672-6.
9. Ernst E, Resch KL. Fibrinogen as a cardiovascular risk factor: a meta-analysis and review of the literature. *Ann Intern Med.* 1993;118:956-63.
10. Jain A, Gupta H, Narayan S. Hyperfibrinogenemia in patients of diabetes mellitus in relation to glycemic control and urinary albumin excretion rate. *J Association Physicians India.* 2001;49:227-30.
11. Expert Panel on Detection E. Executive summary of the Third Report of the National Cholesterol Education Program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III). *JAMA.* 2001;285:2486-97.
12. Haffner SM. Dyslipidemia management in adults with diabetes. *Diabetes care.* 2004;27:S68-71.
13. Ziemer DC, Kolm P, Weintraub WS, Vaccarino V, Rhee MK, Twombly JG, et al. Glucose-independent, black-white differences in hemoglobin A1c levels: a cross-sectional analysis of 2 studies. *Annals Int Med.* 2010;152:770-7.
14. Charan J, Biswas T. How to calculate sample size for different study designs in medical research? *Indian J Psychol Med.* 2013;35:121-6
15. Mahendra J, Kumar SD, Anuradha TS, Talikoti P, Nagaraj RS, Vishali V. Plasma fibrinogen in type 2 diabetic patients with metabolic syndrome and its relation with ischemic heart disease (IHD) and retinopathy. *J Clin Diag Res.* 2015;9:BC18.
16. Dhawale S, Jayant S, Gupta AK. Serum fibrinogen level in type 2 diabetes mellitus patients. *Int J Adv Med.* 2017;3:83-7.
17. Mohan G, Kaur R, Aggarwal A, Singh P. To study levels of serum fibrinogen in type 2 diabetes mellitus and its association with diabetic microvascular complications. *Int J Adv Med.* 2017;4:10-4.
18. Bembde AS. A study of plasma fibrinogen level in type-2 diabetes mellitus and its relation to glycemic control. *Indian J Hematol Blood Transfus.* 2012;28:105-8.
19. Saini PK, Saluja M, Meena SR, Meena SB. Study of plasma fibrinogen level in type 2 diabetes mellitus and its association with glycemic control. *J Assoc Physicians India.* 2016;64:95.
20. Bruno G, Cavallo-Perin P, Barger G, Borra M, D'Errico N, Pagano G. Association of fibrinogen with glycemic control and albumin excretion rate in patients with non-insulin-dependent diabetes mellitus. *Ann Intern Med.* 1996;125:653-7.
21. Mohan V, Shah S, Saboo B. Current glycemic status and diabetes related complications among type 2 diabetes patients in India: data from the A1chieve study. *J Assoc Physicians India.* 2013;61:12-5
22. Unnikrishnan R, Anjana RM, Deepa M, Pradeepa R, Joshi SR, Bhansali A, et al. Glycemic control among individuals with self-reported diabetes in India-the ICMR-INDIAB study. *Diab Technol Therap.* 2014;16:596-603.
23. Mittal S, Dwivedi RN, Lalchandani A, Puri A, Mishra P. Correlation of fibrinogen as an indicator of both long and short term glycemic control in diabetes. *JAPI.* 2002;50:129-30.
24. De Feo P, Gaisano MG, Haymond M. Differential effects of insulin deficiency on albumin and fibrinogen synthesis in humans. *J Clin Investigation.* 1991;88:833-40.
25. Danesh J, Lewington S, Thompson SG, Lowe GD, Collins R, Kostis JB, et al. Plasma fibrinogen level and the risk of major cardiovascular diseases and nonvascular mortality: an individual participant meta-analysis. *JAMA.* 2005;294:1799-809.
26. Sinning JM, Bickel C, Messow CM, Schnabel R, Lubos E, Rupprecht HJ, et al. Impact of C-reactive protein and fibrinogen on cardiovascular prognosis in patients with stable angina pectoris: the Athero Gene study. *Eur Heart J.* 2006;27:2962-8.
27. Kaptoge S, Thompson SG, Danesh J, Emerging Risk Factors Collaboration. C-reactive protein, fibrinogen, and cardiovascular risk. *N Engl J Med.* 2013;368:85-6.
28. Park CS, Ihm SH, Yoo KD, Kim DB, Lee JM, Kim HY, et al. Relation between C-reactive protein, homocysteine levels, fibrinogen, and lipoprotein levels and leukocyte and platelet counts, and 10-year risk for cardiovascular disease among healthy adults in the USA. *Am J Cardiol.* 2010;105:1284-8.
29. Danesh J, Collins R, Appleby P, Peto R. Association of fibrinogen, C-reactive protein, albumin, or leukocyte count with coronary heart disease: meta-analyses of prospective studies. *JAMA.* 1998;279:1477-82.
30. Sabeti S, Exner M, Mlekusch W, Amighi J, Quehenberger P, Rumpold H, et al. Prognostic impact of fibrinogen in carotid atherosclerosis: nonspecific indicator of inflammation or independent predictor of disease progression?. *Stroke.* 2005;36:1400-4.
31. Green D, Foiles N, Chan C, Schreiner PJ, Liu K. Elevated fibrinogen levels and subsequent

- subclinical atherosclerosis: the CARDIA study. *Atherosclerosis*. 2009;202:623-31.
32. De Luca G, Verdoia M, Cassetti E, Schaffer A, Cavallino C, Bolzani V, et al. High fibrinogen level is an independent predictor of presence and extent of coronary artery disease among Italian population. *J Thromb Thrombolysis*. 2011;31(4):458-63.
 33. Temelkova-Kurktschiev T, Koehler C, Henkel E, Hanefeld M. Leukocyte count and fibrinogen are associated with carotid and femoral intima-media thickness in a risk population for diabetes. *Cardiovasc Res*. 2002;56:277-83.
 34. Willeit P, Thompson SG, Agewall S, Bergström G, Bickel H, Catapano AL, et al. Inflammatory markers and extent and progression of early atherosclerosis: Meta-analysis of individual-participant-data from 20 prospective studies of the PROG-IMT collaboration. *Eur J Prev Cardiol*. 2016;23:194-205.
 35. Chuang SY, Bai CH, Chen WH, Lien LM, Pan WH. Fibrinogen independently predicts the development of ischemic stroke in a Taiwanese population: CVDFACTS study. *Stroke*. 2009;40:1578-84.
 36. Shankar A, Wang JJ, Rohtchina E, Mitchell P. Positive association between plasma fibrinogen level and incident hypertension among men: population-based cohort study. *Hypertension*. 2006;48:1043-9.

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