

Correlation between Fasting Blood Sugar Level, HbA1C Level and Serum Lipid Levels in Type 2 Diabetes Mellitus Patients

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ABSTRACT

Introduction: Diabetes Mellitus is one of the most common endocrinal diseases in the world. Incidences of this disease are increasing worldwide and this disease is called disease of this millennium. This study was undertaken to correlate fasting blood sugar level, Glycosylated haemoglobin (HbA_{1c}) level and serum lipid levels in patients with diabetes mellitus.

Material and Methods: This study was a cross sectional study conducted on 100 patients of diabetes mellitus came to M.B Govt. Hospital, Udaipur. The fasting blood sugar (FBS) levels, HbA_{1c} levels and serum lipid levels were performed and then correlated fasting blood sugar level with HbA_{1c} levels and FBS and HbA_{1c} with serum lipid levels. There was a significant positive correlation between FBS and HbA_{1c}, and FBS and HbA_{1c} with serum cholesterol and serum triglycerides level and negative correlation with serum HDL-cholesterol levels.

Results: This study demonstrated that HbA_{1c} level was increased in diabetics and it showed correlation with the status of control of diabetes.

Conclusion: Diabetics have got increased level of serum cholesterol, triglycerides and decreased levels of serum HDL-cholesterol. HbA_{1c} showed stronger correlation with serum cholesterol and triglycerides as compared to FBS. HDL-cholesterol showed stronger correlation with FBS than HbA_{1c}.

Keywords: Diabetes Mellitus (DM), Fasting Blood Sugar (FBS), Glycosylated Haemoglobin (HbA_{1c}), Serum Cholesterol, Serum Triglycerides, Serum HDL-Cholesterol.

INTRODUCTION

Diabetes Mellitus (DM) refers to a group of common metabolic disorder that share the phenotype of hyperglycaemia caused due to either deficiency of insulin secretion or insulin resistance.¹ Diabetes Mellitus is one of the most common endocrinal Diseases in the world. Incidences of this disease are increasing worldwide and this disease is called disease of this millennium. The worldwide prevalence of this disease has risen dramatically over the past two decades, from an estimated 30 million in 1985 to 85 million in 2010 and 415 million in 2017. India is thought to be capital for DM, the incidences of this disease is 73 million in 2015.¹

Diabetes mellitus is commonly associated with abnormalities of carbohydrate metabolism, lipid metabolism, insulin resistance etc.

One of the common metabolic abnormalities in DM individuals is disturbed in lipid metabolism and several form of dyslipidemias has observed in these patients. As many as 60% of diabetics exhibit some degree of hyperlipidemia²

and lipid metabolism appears to be related to the severity and duration of hyperglycaemic state³ and the degree of its control.^{4,5,6}

It has also been reported that hyperlipidemia associated with uncontrolled diabetic state could revert to near normal levels with good control of diabetes and hence can prevent the development of various complications of diabetes.

A good control of DM is believed in diabetic individuals when he can obtain levels of fasting and postprandial blood glucose values as much close to those of the non-diabetic as possible. This concept may be philosophically correct but in actual practice difficult to obtain, and even with quite good control of diabetes, fluctuations in blood glucose level may be marked, not only from day to day but even from hour to hour. As our aim of treatment is not simply the control of blood glucose levels but to kept the total metabolic state to as much normal as possible, the study of hyperglycaemia has distinct limitations as a marker for proper diabetic control.

Therefore, many investigations have been suggested to look out for some other marker which could give us better idea for proper metabolic control. The study of Glycosylated haemoglobin (HbA_{1c}) during last few years has been found to be very helpful in this respect.

The most common pattern of dyslipidemia in DM patients is increased triglyceride and reduced level of HDL cholesterol and it does not affect LDL level.

This study was undertaken to correlate between fasting blood sugar level, HbA_{1c} level and serum lipid levels in type 2 diabetes mellitus.

MATERIAL AND METHODS

It was a cross sectional study conducted on 100 patients of diabetes mellitus, who were admitted/attended in medical wards, medical OPD, diabetic clinic at M.B Govt. Hospital and RNT Medical College, Udaipur (Raj). Approval was

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taken by the Ethical committee. Written informed consent was taken in all patients. Detailed history and examination was done in all patients who were having typical history suggestive of diabetes and satisfied the inclusion criteria. Following criteria were used for diagnosis of Diabetes (inclusion criteria) and following were exclusion criteria:

- Diagnostic criteria for diabetes mellitus:
 - FBS after at least 8 hours of fasting ≥ 126 mg/dl or
 - 2 hours after meal plasma glucose level ≥ 200 mg/dl or
 - Glycosylated haemoglobin ≥ 6.5 % or
 - Symptoms of diabetes plus random blood glucose concentration ≥ 200 mg/dl.
- Exclusion criteria includes:
 - Patients with evidence of primary hyperlipoproteinemia
 - Patients with secondary hyperproteinemia due to endocrine diseases such as acromegaly, hypothyroidism, cushing syndrome
 - Patients with nephrotic syndrome
 - Patients with liver diseases
 - Pregnancy
 - Patients of chronic kidney disease and on dialysis
 - Decompensated heart failure.

Somogyi Nelson's (1945)⁷ methods were used for blood sugar (fasting, postprandial, random) estimation. Modified method of Fluckiger and Winterhalter was used for estimation of glycosylated haemoglobin (HbA_{1c}). The plasma lipoproteins were estimated by electrophoretic separation of lipoproteins on agarose gel (Nobel, 1968). Plasma cholesterol was determined by liberman-Buchard reaction.

STATISTICAL ANALYSIS

Statistical analysis was carried out using standard formulae. P value of < 0.05 was considered as a significant. Statistical significance was calculated by using Chi square test.

RESULTS

A total number of 100 patients were enrolled in our study, out of which 47(47%) were male and 53(53%) were female and maximum were in the age group of 60-69 (table-1,2).

Fasting blood sugar level varied from 86 mg/dl to 310 mg/dl with a mean level of 167.63 ± 54.53 mg/dl. HbA_{1c} level varied from 5.42% to 14.78% with a mean level of 9.86 ± 2.56 . The correlation of FBS and HbA_{1c} level in different groups of diabetics shows that patients in good control had FBS level 104.09 ± 11.96 mg/dl and HbA_{1c} level of 6.82 ± 0.92 %. Patients in fairly controlled group had FBS level and HbA_{1c} level of 161 ± 22.97 mg/dl and 8.99 ± 1.61 % respectively. In poorly controlled groups FBS level were 202.5 ± 43.72 mg/dl and HbA_{1c} level were 11.74 ± 1.99 % (table-3).

In these 100 patients serum cholesterol level varied from 145 mg/dl to 300 mg/dl with a mean level of 219.70 ± 41.46 mg/dl and serum triglyceride level varied from 90 mg/dl to 269 mg/dl with a mean level of 193.60 ± 43.14 mg/dl and serum HDL-cholesterol level varied from 20 mg/dl

Age group (years)	No. of patients	%
40-49	25	25.0
50-59	18	18.0
60-69	31	31.0
70-79	21	21.0
≥ 80	5	5.0

Table-1: Age wise distribution

Sex	No. of patients	%
Male	47	47.0
Female	53	53.0

Table-2: Sex wise distribution

Degree of control		Good	Fair	Poor
No. of cases		27	30	53
FBS (mg/dl)	Mean	104.09	161.0	202.50
	S.D.	11.96	22.97	43.72
	S.E.	0.36	0.81	0.95
HbA _{1c} (%)	Mean	6.82	8.99	11.74
	S.D.	0.92	1.61	1.99
	S.E.	0.02	0.05	0.04

Table-3: Showing levels of FBS and HbA1C level in different groups according to control of diabetes

	Correlation coefficient (r)	Significance (P value)
HbA _{1c} and cholesterol	+0.395	< 0.02
HbA _{1c} and triglycerides	+0.397	< 0.02
HbA _{1c} and HDL-cholesterol	-0.45	< 0.01

Table-4: Showing correlation of HbA1C to serum lipid levels in diabetic subjects

	Correlation coefficients (r)	Significance (P value)
FBS and cholesterol	+0.35	< 0.05
FBS and triglycerides	+0.34	< 0.05
FBS and HDL-cholesterol	-0.69	< 0.001

Table-5: Showing correlation of FBS to serum lipid levels in diabetic subjects

dl to 129 mg/dl with a mean level of 44.33 ± 17.49 mg/dl. There was significant correlation between HbA_{1c} and serum cholesterol ($r = 0.395$, $P < 0.02$) and between HbA_{1c} and serum triglycerides ($r = 0.397$, $p < 0.02$). HbA_{1c} and serum HDL-cholesterol show significant negative correlation ($r = -0.45$, $P < 0.01$) (table-4).

There was just significant correlation between FBS and serum cholesterol ($r = 0.35$, $P < 0.05$) and also just significant correlation between FBS and serum triglycerides level ($r = 0.34$, $P < 0.05$). Correlation between FBS and serum HDL-cholesterol was highly significant ($r = -0.69$, $P < 0.001$) but correlation was negative. Significant correlation was observed after applying Chi Square test and Student t test (table-5).

DISCUSSION

Out of the 100 patients we studied, 47(47%) was male and

53 (53%) was female. In our studied FBS level varies 86 mg/dl to 310 mg/dl with a mean level of 167.63 ± 54.53 mg/dl. Values of HbA_{1c} level was in range of 5.42% - 14.78% with a mean level of 9.86 ± 2.56 . This increase in HbA_{1c} level in these patients was significant ($P < 0.001$).

Paulsen et al. (1976)⁸, Javid et al. (1978) studied demonstrated similar type of results in their studies. Mean fasting blood sugar level in diabetic patients with good control was 104.09 mg/dl and level of HbA_{1c} was 6.82%, while in fairly control, the FBS level was 161 mg/dl and level of HbA_{1c} was 8.99% and in those with poor control, the FBS was 202.50 mg/dl and level of HbA_{1c} was 11.74%. The P value (0.001) for FBS and HbA_{1c} between those three groups of diabetic patients was highly significant. This shows that the level of HbA_{1c} in diabetic patients is linearly correlated with the abnormal blood glucose level.

Same has been reported by various workers including Gabbay et al. (1976)⁹ and Elkeles et al. (1978).¹⁰

Kennedy et al. (1979)¹¹ found correlation between FBS and HbA_{1c} levels were satisfactory while Nabarro et al. (1979)¹² found correlation between HbA_{1c} and FBS were not satisfactory. However, in some individual cases, there was no correlation between HbA_{1c} and FBS.

Compagnucci et al. (1981)¹³ observed that during periods of wide fluctuations in blood sugar, HbA_{1c} level remains nearly constant and in these patients measurement of HbA_{1c} is much more valuable in providing the assessment of diabetic control not available from random blood sugar measurements.

In our studied, serum cholesterol level varied from 145 mg/dl to 300 mg/dl (mean 219.70 ± 41.46 mg/dl) which was statistically significant.

Diabetic cases studied by Dinesh Kumar et al. (1967)¹⁴ also showed high serum cholesterol level (238.50 mg/dl) in older untreated diabetics.

Similar observations were also reported by Maleva (1961)¹⁵, Sharma et al. (1970)⁴ and Sosenko et al. (1980).⁵ Nikkila et al. (1978)¹⁶ found high serum cholesterol levels in poorly controlled diabetic males as well as in well controlled obese males.

The increase in cholesterol level appears to be due to increased cholesterol synthesis during poor or no control of hyperglycaemic state, which returns to normal or near normal after good control of their diabetic state. Obesity is an additional cause of enhanced cholesterol production.

In our studied, serum triglycerides level varied from 90 mg/dl to 269 mg/dl with a mean level of 193.60 ± 43.14 mg/dl which was statistically significant. Our finding was consistent with many studies.

However, these levels were elevated in diabetics who were in poor control as compared to well controlled diabetics and also in obese male diabetics, although they were in good control.

Akeel bai-Yaqobi et al. (2011)¹⁷, Piia P et al. (2012)¹⁸ showed higher level of triglyceride in diabetics.

American Heart Association: Triglyceride (2011), American diabetic service (2012), Diabetic Health-Pub. Med-Metabolic

syndrome also showed that triglycerides level increases in patients with diabetes mellitus.

In our studied, serum HDL-cholesterol level varied from 20 mg/dl to 129 mg/dl with a mean level of 44.33 ± 17.49 mg/dl. The value of plasma HDL-cholesterol was significant low in diabetic subjects. This is in conformity with the studies of Lopes-Virella et al. (1982).¹⁹

In our studied, there was statistically significant direct correlation between HbA_{1c} levels and cholesterol, triglycerides while significant negative correlation was observed between HbA_{1c} levels and plasma HDL-cholesterol levels.

Peterson et al. (1977)²⁰ showed direct correlation between HbA_{1c} and serum triglycerides and cholesterol levels.

On the contrary Gonen et al. (1977)²¹ did not demonstrated any correlation between HbA_{1c} and serum cholesterol and triglyceride levels while Gabbay et al. (1977)²² demonstrated direct correlation between HbA_{1c} and serum cholesterol.

Lopes-Virella et al. (1981)¹⁹ and Falko et al. (1981)²³ demonstrated significant inverse correlation between HbA_{1c} and serum HDL-cholesterol level.

In our studied there was statistically significant direct correlation between FBS level and total cholesterol level, triglycerides level, while significant negative correlation with was observed between FBS level and serum HDL cholesterol level.

Samatha P et al (2012)²⁴ studied that negative correlation of FBS with HDL cholesterol level and a positive correlation of FBS with total cholesterol level and triglycerides level.

On comparison we found that HbA_{1c} was definitely a better marker of diabetic control as compared to FBS.

While correlation of HbA_{1c} to serum cholesterol was significant ($r = 0.39$, $P < 0.02$), it was just significant between FBS and serum cholesterol ($r = 0.35$, $P < 0.05$).

Similarly correlation between HbA_{1c} to serum triglycerides was significant ($r = 0.39$, $P < 0.02$), it was just significant between FBS and serum triglycerides ($r = 0.34$, $P < 0.05$).

HDL cholesterol correlates more significantly with FBS ($r = -0.69$, $P < 0.001$) than with HbA_{1c} ($r = -0.45$, $P < 0.01$).

CONCLUSION

100 patients of diabetes mellitus were studied to determine correlation between FBS level, HbA_{1c} level and serum lipid levels. In this study we observed that mean value for FBS in diabetics was 167.63 mg/dl and mean value of HbA_{1c} were found to be raised in diabetic patients and in this study it was 9.86%. In good control group, FBS was 104.09 mg/dl and HbA_{1c} level was 6.82%. In fairly controlled group, FBS was 161.0 mg/dl and HbA_{1c} level was 8.99%. In poorly controlled group, FBS was 202.5 mg/dl and HbA_{1c} level was 11.74%. Analysis of some individual cases revealed discrepancy between FBS and HbA_{1c} level. However HbA_{1c} showed better correlation to status of diabetic control than fasting blood sugar level. Serum cholesterol, triglycerides were also raised in diabetic patients. Mean value of these were 219.70 mg/dl and 193.60 mg/dl respectively. Serum HDL-cholesterol level were lower in these studied patients. Mean

value was 44.33 mg/dl. Both HbA_{1c} and FBS showed direct positive correlation with serum cholesterol, triglycerides and negative correlation with HDL-cholesterol. Correlation of HbA_{1c} to serum cholesterol, triglycerides was stronger as compared to that of FBS but HDL-cholesterol showed better correlation with FBS than with HbA_{1c}.

Hence we conclude that HbA_{1c} level was increased in diabetics and it shows correlation with the status of control of diabetes. Diabetics have got increased level of serum cholesterol, triglycerides and decreased levels of serum HDL-cholesterol. HbA_{1c} showed stronger correlation with serum cholesterol, triglycerides as compared to FBS. HDL-cholesterol showed more stronger correlation with FBS than HbA_{1c}.

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