

Study of Glycated Haemoglobin and Lipid Profile in Type-2 Diabetes Mellitus

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ABSTRACT

Introduction: Diabetes Mellitus is characterized by chronic hyperglycemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action, or both.

Objective: To compare the biochemical parameters which included glycated haemoglobin, serum total cholesterol, triglyceride, high density lipoprotein cholesterol and low density lipoprotein cholesterol of people with diabetes mellitus and matched non-diabetic controls.

Methods: The cross-sectional hospital-based study was conducted among 60 diabetic and 30 non diabetic patients. Fasting blood samples of 5 ml were collected from both the study sample and control sample. Biochemical parameters like glycated haemoglobin, serum total cholesterol, serum triglyceride, serum high density lipoprotein cholesterol and serum low density lipoprotein cholesterol were analyzed with the help of semi-automated analyzer, Erba Chem5 and Colorimeter-Systronic. Means of glycated haemoglobin, total cholesterol, triglyceride, high density lipoprotein and low density lipoprotein were estimated among the cases and controls. Student's t test was used to compare the mean values.

Results: A statistically significant difference was observed in mean glycated haemoglobin, total cholesterol, triglyceride, high density lipoprotein and low density lipoprotein among the cases and controls (p-value<0.05).

Conclusions: This study concluded that there was a significant difference in mean glycated haemoglobin, total cholesterol, triglyceride, high density cholesterol and low density cholesterol among the cases and controls. It is suggestive that lipid profile must be considered among the diabetic patients to which could be beneficial to prevent risk of cardiovascular complications.

Keywords: Diabetes Mellitus; Glycated Haemoglobin; Lipid Profile.

INTRODUCTION

Diabetes Mellitus (DM) is a heterogeneous group of metabolic disorders. It is characterized by chronic hyperglycaemia with disturbances of carbohydrate,

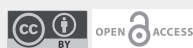
fat and protein metabolism resulting from defects in insulin secretion, insulin action, or both.¹ DM is caused by a complex interaction of genetics and environmental factors.

The metabolic dysregulation associated with DM causes secondary pathophysiologic changes in multiple organ systems.² The effects of DM include long-term damage, dysfunction, and failure of various organs, especially the eyes, kidneys, heart, and blood vessels.¹ These changes lead to the development of clinical complications of diabetes.³

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Chronic hyperglycaemia, from whatever cause, leads to a number of complications - cardiovascular, renal, neurological, ocular and recurrent infections.⁴ Increasing incidence of DM may be a leading cause of morbidity and mortality for the foreseeable future. The worldwide prevalence of DM has risen dramatically over the past two decades. Although the prevalence of both type 1 and type 2 DM is increasing worldwide, obesity and reduced physical activity is thought to cause result in increased prevalence of type 2 DM.²

This study aims to compare the biochemical parameters which included glycated haemoglobin (HbA_{1c}), serum total cholesterol (TC), triglyceride (TG), high density lipoprotein cholesterol(HDL) and low density lipoprotein cholesterol (LDL) between DM patients and matched non-diabetic participants.

METHODS

It was a hospital based cross-sectional observational study conducted from 2011 to 2012 A.D in the Department of Biochemistry, Mamata Medical College and General Hospital, Khammam, Andhra Pradesh, India. A sample size of 60 cases and 30 non-diabetic participants were recruited as controls from 40 years to 65 years.

The cases were patients diagnosed with DM from

the age group of 40-65 years. The controls were healthy non diabetic subjects matched according to age and gender.

Fasting blood samples of 5 ml were collected after taking written informed consent from both cases and controls. All aseptic precautions were taken during blood collection for serum lipid profile and HbA_{1c}.

Serum was separated within one hour. Biochemical parameters analyzed were HbA_{1c}, TC, TG, HDL and LDL with the help of semi-automated analyzer, Erba Chem5 and Colorimeter-Systronic. On the basis of HbA_{1c} levels, the diabetes patients were further classified into two groups one with HbA_{1c} levels less than 8.0% and another with HbA_{1c} levels from greater than 8.0%.

Data was entered into Microsoft excel. Student’s t-test was used to compare the mean values (parameters) using SPSS version 16.

RESULTS

Most of the cases 31 (52%) were from the sub group with HbA_{1c} levels less than 8.0% as shown in Table 1.

A significant difference was observed between mean HbA_{1c}, TC, TG, HDL and LDL among the cases and controls as shown in Table 2 with p-values <0.05.

Table 1: General characteristics of the participants

	Mean HbA _{1c}	Number of subjects in each group	Group
Non-diabetic control subject	5.44%	30	Control
Diabetes patients	8.02%	60	
Sub-groups	6.94%	31	Good Control
	9.16%	29	Poor Control

Table 2: Comparison of HbA_{1c} and lipid profile between control and cases using Student’s t-test

	HbA _{1c} (%)	TC (mg/dl)	TG (mg/dl)	HDL(mg/dl)	LDL(mg/dl)
Control (n=30)	5.44 ±0.31	155.03 ±18.50	97.07 ±28.86	43.70 ±2.25	91.87 ±16.31
DM (n=60)	8.02 ±1.39	181.38 ±40.66	116.25 ±40.87	36.65 ±3.87	121.27 ±36.45
P-value	0.0001	0.0011	0.0240	0.0001	0.0001

Table 3: Comparison of HbA1c and lipid profile between sub group-I and sub-group-II using Student's t-test

	HbA _{1c} (%)	TC (mg/dl)	TG (mg/dl)	HDL (mg/dl)	LDL (mg/dl)
Sub group-I (n=31)	6.94 ±0.66	167.97 ±35.84	101.68 ±27.30	37.87 ±4.27	109.61 ±32.53
Sub group-II (n=29)	9.16 ±0.99	195.72 ±41.16	131.83 ±47.26	35.34 ±2.93	133.72 ±36.81
P-value	0.0001	0.0071	0.0034	0.0101	0.0093

Table 4: Comparison of HbA1c and lipid profile among sub group-I and sub-group-II with control using Student's t-test

	Control n=30	Sub group-I n=31	P-value	Sub group-II N=29	P-value
HbA _{1c} (%)	5.44 ±0.31	6.94 ±0.66	0.0001	9.16 ±0.99	0.0001
TC (mg/dl)	155.03 ±18.50	167.97 ±35.84	0.0832	195.72 ±41.16	0.0001
TG (mg/dl)	97.07 ±28.86	101.68 ±27.30	0.5239	131.83 ±47.26	0.0012
HDL (mg/dl)	43.70 ±2.25	37.87 ±4.27	0.0001	35.34 ±2.93	0.0001
LDL (mg/dl)	91.87 ±16.31	109.61 ±32.53	0.0096	133.72 ±36.81	0.0001

The mean HbA_{1c}, total cholesterol, triglyceride, HDL and LDL were also statistically different among the sub groups with p-value<0.05 as shown in table 3.

The comparison of meanHbA_{1c}, total cholesterol, triglyceride, HDL and LDL between the controls and sub-groups 1 using student's t-test also depicted statistically significant difference as shown in table 4. The mean values when compared between control and sub group 2 also showed a statistically significant difference.

Student's t test showed there was a significant difference in mean values of HbA1c and lipid profile among sub group-I and sub-group-II with control.

DISCUSSION

A significant difference was seen between the diabetic population and controls (p-value<0.05) in HbA1c and lipid profile. These observations of the present study correlates well with other previously mentioned studies. This increased fasting as well as post prandial plasma glucose is due to impaired insulin secretion and insulin resistance of the disease process in DM. Glycosylated haemoglobin

(HbA_{1c}) is formed by post translational changes in the haemoglobin molecule, and their levels correlate well with glycemic levels over the previous six to ten weeks. Persistent hyperglycemia causes continuous nonenzymatic condensation of plasma glucose with haemoglobin, contributes to rise of HbA_{1c} in diabetics.⁵

HbA_{1c} is considered as a diagnostic tool along with the follow up parameter by recent American Diabetic Association (ADA) guidelines. The ADA suggests that the glycaemic goal is to achieve HbA_{1c} value as close to normal as possible without significant hypoglycaemia. In general, the target HbA_{1c} should be<7.0% with a more stringent target (<6%) for patients with other associated risk factors. Other groups(International Diabetes Federation and American Association of Clinical Endocrinology) have suggested that the HbA_{1c} goal should be≤6.5% in most individuals, based primarily on the observation that there is no lower limit of HbA_{1c} in terms of reducing diabetes-specific complications.⁶

In our study, the increases in mean serum cholesterol, triglyceride, LDL along with decrease of serum HDL were proportional to glycemic status (HbA_{1c}) in diabetic's sub-groups when compared to controls.

These observations suggested diabetic dyslipidemia. The mean serum total cholesterol, triglyceride, HDL and LDL levels were 181.38mg/dl, 116.25 mg/dl, 36.65 mg/dl, 121.27 mg/dl respectively in the study group and 155.03 mg/dl, 97.07 mg/dl, 43.70 mg/dl, 91.87 mg/dl respectively in the control group. The mean difference of total cholesterol, triglyceride, HDL and LDL levels were significant between study group and control.⁷ which is characterized by hyperglycaemia, but also with lipid and protein metabolism disorders. Patients with type 2 diabetes have a high risk for cardiovascular disease (CVD

The mean serum total cholesterol, triglyceride, HDL and LDL levels were 167.97mg/dl, 101.68 mg/dl, 37.87 mg/dl, 109.61 mg/dl respectively in the sub group-I and 195.72 mg/dl, 131.83 mg/dl, 35.34 mg/dl, 133.72 mg/dl respectively in the sub group-II. In the two sub group-I & II the mean difference of total cholesterol, triglyceride, HDL and LDL levels were significant. The mean difference of total cholesterol & triglyceride levels were not significant between control and sub group-I whereas the HDL and LDL levels were significant. The mean difference of total cholesterol, triglyceride, HDL and LDL levels among control and sub group-II, were significant.⁸

HbA_{1c} exhibited direct correlations with cholesterol, triglyceride and LDL and inverse correlation with HDL. There was a linear relationship between HbA_{1c} and dyslipidemia. The levels of serum cholesterol and triglyceride were significantly higher and HDL significantly low in patients with worse glycemic control as compared to patients with good glycemic control. Increase of serum TC, serum TG, serum LDL and decrease of serum HDL were contributed by impaired insulin secretion and insulin resistance of the disease process in diabetes mellitus. These findings are in consistent with other studies.^{9,10}

From cardiovascular point of view, it may be appropriate to say, "Diabetes is a cardiovascular disease" and diabetic dyslipidemia (↓HDL, ↑LDL, ↑TG, ↑TC), accounts for part of the elevated cardiovascular risk in these patients. While diabetic

patients often have LDL cholesterol levels near average but the LDL particles tend to be smaller and denser, and, therefore, more atherogenic. The key feature of diabetic dyslipidemia is an increase in the production of very low density lipoprotein (VLDL) by the liver in response to elevations in free fatty acids (FFA). Although insulin mediates the uptake of FFA by striated muscle, reducing the levels presented to the liver, insulin resistance results in the opposite effect, increasing the levels of FFA available to the liver. The UKPDS confirmed the positive association between plasma glucose levels and coronary heart disease (CHD) risk for HbA_{1c} levels greater than 6.2% in patients with diabetes. CHD risk increased by 11% with each one percentage point elevation in HbA_{1c}. So, HbA_{1c} is not only a predictor of glycemic status but it reflects the risk of developing cardiovascular disease in diabetes patients. According to guidelines of ADA and American Heart Association, the target lipid values in diabetic individuals (age>40 years), without cardiovascular disease, should be LDL cholesterol<100 mg/dl, HDL cholesterol>40 mg/dl in men, and >50 mg/dl in women and Triglycerides<150 mg/dl.⁹

The increase in cardiovascular morbidity and mortality appears to relate to the synergism of hyperglycemia, dyslipidemia and insulin resistance. Because of the additive cardiovascular risk of hyperglycemia and hyperlipidemia, lipid abnormalities should be aggressively detected and treated as a part of comprehensive diabetes care. A combination of appropriate diet, therapy and exercise, can correct dyslipidemia. Mixed results of HbA_{1c} were found in different articles with different lipid profile components.¹⁰⁻¹⁵

Different risk factors like change in life style, poor dietary intake and low physical exercise could be the reason for mixed results.^{15,16} Thus, measures like doing regular exercise, promoting good food habits, and controlling diet helps to improve or control diabetic dyslipidemia.^{17,18}

CONCLUSIONS

This study clearly concludes that HbA_{1c} is not only a useful biomarker of long term glycemic control but also a good predictor of lipid profile. So, monitoring of glycemic control using HbA_{1c} could have additional benefits of identifying diabetic patients who are at

a greater risk of cardiovascular complications and it can help the clinicians to develop a plan with appropriate diet, exercise & drug therapy to avert macrovascular complications.

Conflict of Interest: None

NJHS

REFERENCES

1. Bennett, P. H. & Knowler, W. C. Definition, diagnosis, and classification of diabetes mellitus and glucose homeostasis. *Joslin's Diabetes Mellitus: Fourteenth Edition* (2011).
2. Biggs, J. B. Complementary, Alternative, and Integrative Health Practices. *Harrison's Princ. Intern. Med. Part 1* (2015).
3. Currie, C. Davidson's Principles and Practice of Medicine 21st Edition. *Cambridge Med. J.* (2011) doi:10.7244/cmj-1295192191.
4. Sampson, M. *et al.* Health Promotion Advocate Extends Benefits Offered to Adolescents, Young Adults. *Addiction* **111**, (2016).
5. Wernicke, K. *et al.* Influence of physical activity on periodontal health in patients with type 2 diabetes mellitus. A blinded, randomized, controlled trial. *Clin. Oral Investig.* **25**, (2021).
6. Meng, J. M. *et al.* Effects and mechanisms of tea for the prevention and management of diabetes mellitus and diabetic complications: An updated review. *Antioxidants* vol. 8 (2019).
7. Stefanović, A. *et al.* Dyslipidemia in type 2 diabetes mellitus. *Arhiv za Farmaciju* vol. 69 (2019).
8. Vinodmahato, R. *et al.* Association between glycaemic control and serum lipid profile in type 2 diabetic patients: Glycated haemoglobin as a dual biomarker. *Biomed. Res.* **22**, 375–380 (2011).
9. Mohamed, E., Mohamed, M. & Rashid, F. A. Dyslipidaemic pattern of patients with type 2 diabetes mellitus. *Malaysian J. Med. Sci.* **11**, 44–51 (2004).
10. Bhowmik, B. *et al.* Serum lipid profile and its association with diabetes and prediabetes in a rural Bangladeshi population. *Int. J. Environ. Res. Public Health* **15**, 1–12 (2018).
11. Baranwal, J. K., Maskey, R., Majhi, S., Lamsal, M. & Baral, N. Association between level of HbA_{1c} and lipid profile in T2DM patients attending diabetic OPD at BPKIHS. *Heal. Renaiss.* **13**, 16–23 (2017).
12. Soiza, R. L., Donaldson, A. I. C. & Myint, P. K. Vaccine against arteriosclerosis: an update. *Ther. Adv. Vaccines* **9**, 259–261 (2018).
13. Al, S. *et.* Original Research Article Correlation Between Glycemic Parameters and Lipid Profile in Type 2 Diabetic. *Jemc* **7**, 20–24 (2017).
14. Hu, F. B. Globalization of diabetes: The role of diet, lifestyle, and genes. *Diabetes Care* **34**, 1249–1257 (2011).
15. Rosiek, A. *et al.* TCRM-118014-health-behaviors-of-patients-diagnosed-with-type-2-diabetes-. *Dove Press J.* **12**, 1783–1792 (2016).
16. Wu, N. & Li, J. Clinical considerations of lipid target and goal in dyslipidemia control. *Chronic Dis. Transl. Med.* **2**, 3–6 (2016).
17. Hou, Q. *et al.* Characteristics of lipid profiles and lipid control in patients with diabetes in a tertiary hospital in Southwest China: an observational study based on electronic medical records. *Lipids Health Dis.* **18**, 1–8 (2019).
18. Guy, J. *et al.* Lipid and lipoprotein profiles in youth with and without type 1 diabetes: The SEARCH for diabetes in youth case-control study. *Diabetes Care* **32**, 416–420 (2009).