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RESEARCH ARTICLE

A comparative study of lipid profile, body mass index, and waist circumference among Type 2 diabetes mellitus patients with poor and good metabolic control and normal age-matched control group

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ABSTRACT

Background: Prevalence of dyslipidemia is very common in Type 2 diabetes mellitus (DM), and lipid abnormalities are likely to play an important role in the development of the atherosclerotic vascular disease. Type 2 diabetic patients are obese, and obesity as an independent risk factor for diabetes also complicates the management and exacerbates the metabolic abnormalities in diabetes. **Aims and Objectives:** To compare the lipid profile, body mass index (BMI), and waist circumference (WC) in Type 2 diabetic patients with poor and good metabolic controls with that of normal controls and to study the correlation between glycosylated hemoglobin (HbA_{1c}) values and triglycerides (TG), high-density lipoprotein (HDL) in patients with Type 2 DM. **Materials and Methods:** The descriptive comparative study group of 150 subjects was divided into three groups based on HbA_{1c} values which included Type 2 diabetic patients with poor metabolic control, good metabolic control, and normal age-matched controls. **Results:** There is a significant increase in the mean levels of total cholesterol, TG, low-density lipoprotein (LDL), and Very low density lipoproteins (VLDL) values in diabetic patients with both poor metabolic control and good metabolic control when compared to normal controls. There is a significant decrease in mean HDL values and significant elevation of mean waist circumference and BMI values in both male and female diabetics with poor and good metabolic controls when compared to normal controls. Highly significant positive correlation was obtained between HbA_{1c} and TG and a negative correlation between HbA_{1c} and HDL. **Conclusion:** Increase in TG and decline in HDL with HbA_{1c} rise shows the impact of glycemic control on lipoprotein levels. Majority of diabetic patients were overweight and had abdominal adiposity. Good metabolic control of hyperglycemia will prevent alteration of lipid metabolism helping in better prognosis and preventing manifestations of vascular and typical secondary complications.

KEYWORDS: Glycosylated Hemoglobin; Dyslipidemia; Type 2 Diabetes Mellitus; Body Mass Index; Waist Circumference

INTRODUCTION

Type 2 diabetes mellitus (DM) is the predominant form of diabetes worldwide, accounting for 90% of cases globally.[1] DM is a heterogeneous group of metabolic disorders characterized by chronic hyperglycemia with disturbance of carbohydrate metabolism resulting from a defect in insulin secretion, insulin action or both. The dramatic rise in the prevalence of Type 2 diabetes and the related disorders such as dyslipidemia, obesity, and hypertension could be related to rapid changes in lifestyle that has occurred during the past 50 years.[2]

Prevalence of dyslipidemia is very common in Type 2 DM, and lipid abnormalities are likely to play an important role in the development of the atherosclerotic vascular disease. The

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most frequent abnormalities seen are hypertriglyceridemia with or without hypercholesterolemia and decreased high-density lipoprotein (HDL) concentration.[3] Hyperglycemia and insulin resistance plays an important role in the pathophysiology of dyslipidemia in Type 2 DM. All these contribute to accelerate atherogenesis in Type 2 DM.

Central adiposity indicates deposition of large quantities of abdominal fat, which consist of visceral fat and subcutaneous fat. Visceral fat increases the risk of diabetes and hyperlipidemia by favouring insulin resistance. Waist circumference (WC) has been used as measures of central obesity, and BMI has been used as a measure of general obesity.[4] WC is independently associated with an increased risk of diabetes. Overall adiposity may be linked to low to moderate levels of insulin resistance, and abdominal adiposity may be more closely involved in the advance of abnormalities in glucose metabolism.[5] Obesity associated with a defect in insulin sensitivity is the result of both pre- and post-receptor abnormalities.[6] It impairs the ability of insulin to influence glucose uptake and metabolism in insulin-sensitive tissues of the body.

Aim and Objectives

1. To compare the lipid profile, body mass index (BMI) and waist circumference (WC)in type 2 diabetic patients with poor and good metabolic control with that of normal control.
2. To study the correlation between glycosylated hemoglobin (HbA_{1c}) values and triglycerides (TG), HDL in patients with Type 2 DM.

MATERIALS AND METHODS

The descriptive comparative study which was approved by Institutional Ethics Committee was conducted for a period of 6 months in patients attending the Diabetic Clinic, Medical College, Calicut. Study was conducted in 150 subjects with 50 subjects in each group of age 30-65years.

Selection of Subjects

Three study groups were selected. Based on HbA_{1c} values, patients were divided into two groups.

1. Group 1: Type II diabetic patients with poor metabolic control with HbA_{1c} values >6.5.
2. Group 2: Type II diabetic patients with good metabolic control with HbA_{1c} values <6.5.
3. Group 3: Normal age-matched control. There was an equal distribution of males and females in all the study groups.

Study Design

This study was a descriptive comparative study.

Exclusion Criteria

Patients with history of smoking, alcohol consumption, acute infections and inflammatory diseases, hepatic or renal disease, coronary heart disease, macrovascular, and microangiopathic complications in diabetes were excluded from the study.

8-12 h fasting blood samples were collected for estimation of lipid profile and HbA_{1c}. The biochemical parameters were done in the Clinical Laboratory of Biochemistry department, Medical College Calicut.

Estimation of HbA_{1c} was done by HbA_{1c} kit using Ion Exchange resin method. This method was described by Bunn[7] and analyzed using photoelectric colorimeter (Systronics 114). Lipid profile was estimated using automated analyzer (Erba). The Friedewald's equation was used to calculate very low-density lipoprotein (VLDL) and LDL cholesterol.[8]

WC was measured in centimeters using a tape kept horizontally midway between lower costal margin and the upper border of iliac crest at right mid-axillary line with the subject standing in gentle expiration. International diabetes federation criteria for central adiposity[9] is ≥90 cm (35 inches) in males and ≥80 cm (31.5 inches) in females of South Asia, Chinese, and Ethnic South and Central America.

Body weight was measured using a calibrated weighing scale, without shoes and lightly clothed, in a standing posture in kilograms (kg). Height was measured using standard height meters, in standing upright position in centimeters (cm), and then it was converted into meters. BMI was calculated using the formula weight (kg)/height (m^2).

According to the World Health Organization classification of adults based on BMI:[10]

BMI - kg/m^2: Classification

1. <18.5: Underweight
2. 18.5-24.9: Normal weight
3. 25-29.9: Overweight
4. 30-34.9: Class I obesity
5. 35-39.9: Class II obesity
6. >40: Class III obesity.

Statistical Analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 14. Results were expressed as mean ± standard deviation. Mean difference between the groups were analyzed using ANOVA (Analysis of Variance). $P < 0.05$ was taken as the level of significance. To find out whether there is a significant association or not between two variables, coefficient of correlation was calculated. The correlation coefficient used to denote association between two continuously measured variable is the Pearson's

correlation coefficient. Correlation coefficient "r" tends to lie between +1.0 and −1.0. If r is near +1, it indicates a strong positive association between X and Y that is when one variable increases the other variable also increases. A value near −1.0 indicates a strong negative association that is when one variable increases other decreases.

RESULTS

Observations of the present study were recorded in Table 1 & Figures 1 and 2.

There is significant elevation of total cholesterol (TC) in diabetics with poor control and good control when compared to normal. The mean values were also significant when diabetics with poor control were compared to diabetics with good control (P = 0.000 significant). There was significant elevation of TG in diabetics with poor metabolic control and good metabolic control when compared to normal controls with P = 0.000. Significant elevation of mean LDL in diabetics with poor control when compared to diabetics with good control and normal (P = 0.000). The rise in mean LDL values were also significant when diabetics with good control were compared to normal (P = 0.001). Significant elevation of mean VLDL values when diabetics with both poor metabolic control and good metabolic control were compared to normal with P = 0.000 and 0.003, respectively. However, the rise in mean VLDL values were not statistically significant when diabetics with poor control were compared to good metabolic control (P = 0.146). There was significant elevation of mean HDL values in normal controls when compared to diabetics with poor metabolic control (P = 0.000) and good control (P = 0.001). Significant elevation of mean WC values in both male diabetic groups when compared to normal (P = 0.000). Significant elevation of mean WC values in both female diabetic groups when compared to normal (P = 0.000). Significant elevation of the mean BMI values in diabetics with both poor control and good control when compared to normal (P = 0.000). The BMI values were also significant when diabetics with poor control were compared to diabetics with good control (P = 0.000). Highly significant positive correlation has been found between HbA_{1c} and TG (Figure 1). Highly significant negative correlation also has been found between HbA_{1c} and HDL cholesterol (Figure 2).

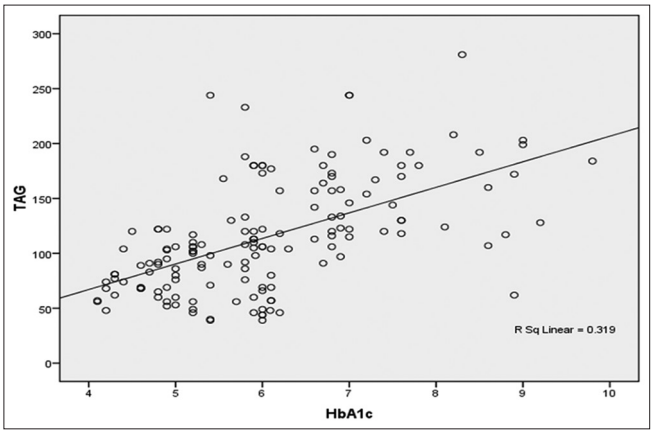

Figure 1: Scatter plot regarding the correlation between glycosylated hemoglobin and triglyceride values in cases. Positive correlation; correlation coefficient, r = 0.56; P = 0.00 (highly significant)

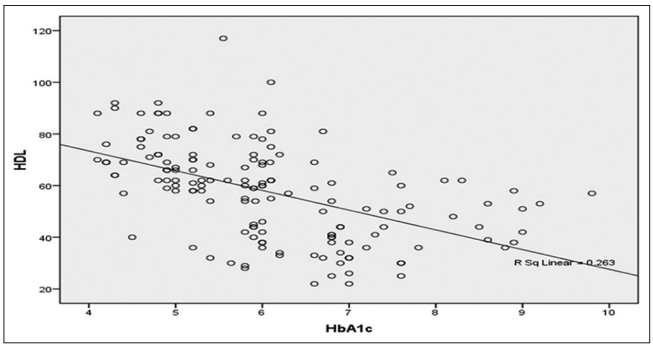

Figure 2: Scatter plot showing the correlation between glycosylated hemoglobin and high-density lipoprotein cholesterol values in cases. Negative correlation; correlation coefficient, r = −0.5; P = 0.00 (highly significant)

DISCUSSION

The present study was conducted to find the relation between HbA_{1c} and lipid level in patients with Type 2 DM. The results of the present study showed a significant increase in the mean levels of TC, TG, LDL, and VLDL values in diabetic patients with both poor metabolic control and good metabolic control when compared to normal controls (Table 1). These values were also significant when compared between diabetic patients with good and poor metabolic control. There was a significant decrease in HDL cholesterol in diabetic patients with poor and good metabolic control when compared to normal. (Table 1) The decline in HDL was also significant when diabetics with poor metabolic control were compared to good metabolic control.

A positive correlation was found between HbA_{1c} and TG (Figure 1) and a negative correlation between HbA_{1c} and HDL (Figure 2). These findings were consistent with results obtained by Khan[11] and Khan *et al*.[12] These findings suggest that HbA_{1c} can provide valuable supplementary information about the extent of circulating lipids besides its primary role in monitoring long-term glycemic control. Increase in TG and decline in HDL with HbA_{1c} rise shows the impact of glycemic control on lipoprotein levels and that hyperlipidemia of diabetic patients may be correctable by improving blood sugar.

Hypertriglyceridemia may be due to insulin resistance causing defective glucose utilization and fatty acid mobilization from adipose tissue. These fatty acids are mobilized for energy purpose, and excess fatty acids are accumulated in the liver which is converted into TG.[13] Suryavanshi *et al*.[14] suggested that insulin resistance is associated with the diminished

Table 1: Mean values of serum lipids, BMI, WC in study groups

Parameters	Type 2 DM poor metabolic control	Type 2 DM good metabolic control	Normal controls
HbA_{1c} %	7.49±0.84	5.64±0.48	5.05±0.60
TC (mg/dl)	223.24±37.31	184.56±30.60	162.32±20.80
TG (mg/dl)	156.14±42.68	111.62±37.97	77.46±24.57
LDL (mg/dl)	147.99±36.58	102.69±28.88	79.54±32.13
VLDL (mg/dl)	31.22±8.53	26.14±7.48	15.72±4.97
HDL (mg/dl)	44.02±13.10	59.54±12.60	69.42±11.88
BMI (kg/m^2)	26.53±1.89	23.40±1.52	21.92±1.34
Male WC (cm)	98.09±3.56	92.68±1.87	89.99±2.01
Female WC (cm)	92.87±5.04	82.85±2.65	79.22±2.13

TC: Total cholesterol, TG: Triglycerides, HDL: High-density lipoprotein, VLDL: Very low-density lipoprotein, HbA_{1c}: Glycosylated hemoglobin, LDL: Low-density lipoprotein, DM: Diabetes mellitus, BMI: Body mass index, WC: Waist circumference

level of LDL receptor with an increase in LDL particle and the resultant increase in LDL cholesterol. Individuals with Type 2DM have reduced clearance of VLDL and reduced catabolism of VLDL particle which is an additive factor promoting hypertriglyceridemia. Reduced lipoprotein lipase level in Type 2 DM interfere with normal lipoprotein metabolic cascade resulting in decreased clearance of VLDL. Hyperinsulinemia and central obesity that accompanies insulin resistance also lead to overproduction and impaired catabolism of VLDL.[3] Decline in HDL is due to increased HDL catabolism with augmented TG hepatic lipase activity. TG rich HDL particles are hydrolyzed by hepatic lipase and are rapidly catabolized and cleared from plasma. Low HDL cholesterol is often accompanied by elevated TG levels, and the combination has been strongly associated with an increased risk of coronary heart disease. Increased caloric intake, obesity, and lack of muscular exercise contributes to dyslipidemia observed in Type 2 DM.[14]

In this study, the mean BMI of diabetic patients with poor metabolic control and good metabolic control was significantly higher than normal controls (Table 1). These values were also significant when compared between diabetic patients with poor and good metabolic control. Although this BMI does not fit into the obese category, many of the diabetes patients were overweight.

In this study, there was a significant elevation of mean WC values in both male and female diabetics with poor and good metabolic controls when compared to normal controls. These values were also significant when compared between diabetic patients with good and poor metabolic control (Table 1). The risk for diabetes increases if WC values in men are more than 90, in woman if they are more than 80.[9] In this study, 63% of males had WC more than 90 and 58% of females had WC more than 80. Results clearly depicted that majority of the patients were overweight and had abdominal adiposity. Freemantle *et al*.[15] observed that there is a strong association between abdominal obesity and the development of Type 2 diabetes and reduction of WC decreased the risk of developing Type 2 diabetes.

Central adiposity is strongly linked to insulin resistance because abdominal fat is more lipolytically active than subcutaneous fat because of its greater complement of adrenergic receptors.[16] Lipolytically active intra-abdominal adipocytes release fatty acids into the portal circulation which impair glucose utilization by skeletal muscle, increase glucose production by liver and impair β cell function. Shah *et al*.[17] observed that most of the diabetic patients were overweight and that BMI and waist circumference are independent risk factors for the development of Type 2 diabetes. Production by adipocytes of adiponectin, insulin-sensitizing peptide is reduced in obesity, and this may contribute to hepatic insulin resistance.[18] Adiponectin increases muscle fatty acid uptake and oxidation, decreases muscle and liver TG, and decreases plasma fatty acid. Patients with Type 2 diabetes have reduced circulating adiponectin levels indicating that adiponectin also plays a role in the pathophysiology of lipid abnormalities in Type 2 diabetes.[3]

CONCLUSIONS

Increase in TG and decline in HDL with HbA_{1c} rise shows the impact of glycemic control on lipoprotein levels and that hyperlipidemia of diabetic patients may be correctable by improving blood sugar. Majority of diabetic patients were overweight and had abdominal adiposity. High level of cholesterol, TG, LDL cholesterol, and low HDL cholesterol may be due to obesity, increased caloric intake and lack of muscular exercise in patients of DM. Lifestyle modifications such as weight control with reduction in WC, increased physical exercise along with proper control of hyperglycemia, and hyperlipidemia are effective interventions to ensure a better quality of life prevent adverse cardiovascular outcomes and to retard the progression of microvascular and macrovascular complications in the long run.

REFERENCES

1. King H, Aubert RE, Herman WH. Global burden of diabetes, 1995-2025: Prevalence, numerical estimates, and projections. Diabetes Care 1998;21:1414-31.
2. Mehta SR, Kashyap AS, Das S. Diabetes Mellitus in India: The Modern Scourge. Med J Armed Forces India 2009;65:50-4.
3. Vergès BL. Dyslipidaemia in diabetes mellitus. Review of the main lipoprotein abnormalities and their consequences on the development of atherogenesis. Diabetes Metab 1999;25 Suppl 3:32-40.
4. Obesity: Preventing and managing the global epidemic. Report of a WHO consultation. World Health Organ Tech Rep Ser 2000;894:1-253.
5. Sharma S, Jain S. Prevalence of obesity among Type 2 diabetics. J Hum Ecol 2009;25:31-5.
6. Becker KL, Bilezikian JP, Brenner WJ, Hung CW, Kahn DR, Loriaux L, *et al*. Principles and Practice of Endocrinology. 2nd ed. Philadelphia: J.B. Lippincott Publishers; 1995. p. 1160-1.
7. Bunn HF. Evaluation of glycosylated hemoglobin diabetic patients. Diabetes 1981;30:613-7.
8. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin Chem 1972;18:499-502.
9. Fauci AS, Braunwald E, Kasper D, Hauser S, Longo D, Jameson J, *et al*. Harrison's Principles of Internal Medicine. 17th ed., Vol. 11. New York: McGraw Hill; 2008. p. 2275-82, 2297-302.
10. World Health Organization. Diet, Nutrition and the Prevention of Chronic Diseases. Report of a Joint WHO/FAO Expert Consultation. WHO Technical Report Series No. 916. Geneva: World Health Organization; 2003.
11. Ahmad Khan H. Clinical significance of HbA1c as a marker of circulating lipids in male and female Type 2 diabetic patients. Acta Diabetol 2007;44:193-200.
12. Khan HA, Sobkiand SH, Khan SA. Association between glycaemic control and serum lipid profile in Type2 diabetic patients: HbA1c predicts dyslipidaemia. Clin Exp Med 2007;7:24-9.
13. Shih KC, Kwak CF, Hwa CM. Acipimox attenuates hypertriglyceredemia in dislipidemic Non-insulin dependent diabetes mellitus patients without perturbation of insulin sensitivity and glycemic control. Diabetic Res Clin Pract 1997;36:113-9.
14. Suryavanshi NP, Bhutey AK, Nagdeote AN, Jadhav AA, Manoorkar GS. Study of lipid peroxide and lipid profile in diabetes mellitus. Indian J Clin Biochem 2006;21:126-30.
15. Freemantle N, Holmes J, Hockey A, Kumar S. How strong is the association between abdominal obesity and the incidence of Type 2 diabetes? Int J Clin Pract 2008;62:1391-6.
16. Larsen PR, Kronberg HM, Polonsky KS. William's Textbook of Endocrinology. 10th ed. Philadelphia: Saunders Publications; 2003. p. 1427-37.
17. Shah A, Parthasarathi D, Sarkar D, Saha CG. A comparative study of body mass index (BMI) in diabetic and non-diabetic individuals in Nepalese population. Kathmandu Univ Med J (KUMJ) 2006;4:4-10.
18. Kahn CR, Wier GC, King GL, Jacobson A, Moses AC. Joslin's Text book of Diabetes mellitus. 14th ed. New York: Lippincott Williams and Wilkins; 2005. p. 425-40, 563-69.

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