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Original Article

Biochemistry Section

A Comparative Study on the Fasting and the Postprandial Dyslipidaemia in Type 2 Diabetes Mellitus

LOKHANDE SURYABHAN L, IYER CHANDRASHEKHAR M, SHINDE RATNENDRA R, NANDEDKAR PRERNA D

ABSTRACT

Background and Objectives: Type 2 Diabetes Mellitus (Type 2 DM), which is characterized by a relative insulin deficiency or insulin resistance is associated with a cluster of metabolic abnormalities, which includes glucose intolerance, hypertension, a unique dyslipidaemia, a procoagulant state, and an increase in macrovascular diseases. The present study was conducted to assess the significance of postprandial dyslipidaemia with respect to fasting dyslipidaemia, in the pathogenesis of atherosclerotic changes and possible cardiovascular diseases (CVD) and complications.

Methods and Statistical Analysis: Fifty diagnosed cases of type 2 DM which were in the age group of 35-65 years, which had a duration of diabetes of more than five years, were included in the study and 50 age and sex matched healthy subjects were taken as the controls. In both the study groups, we measured the serum levels of fasting as well as the postprandial lipid profile, which was comprised of the total Cholesterol (TC), triglycerides (TGs), high density lipoprotein cholesterol (HDL-C), low density lipoprotein cholesterol (LDL-C) and the waist-hip ratio (WHI) as the cardiovascular risk factors. The statistical analysis was done by using the Students unpaired't'-test.

Results: The results of this study showed significantly increased levels of serum total cholesterol, TGs, LDL-C and VLDL-C in the postprandial state as compared to those in the fasting state ($p<0.001$) and as compared to those in the fasting and the postprandial states of the controls ($p<0.001$). The serum HDL-C level was significantly lower in the postprandial state as compared to that in the fasting state ($p<0.001$). Also, the postprandial and the fasting HDL-C levels were significantly lower as compared to the levels in their respective control groups ($p<0.001$).

Conclusion: The findings of the present study indicated that the lipid profile, as a cardiovascular risk factor, was significantly elevated in the postprandial state as compared to that in the fasting state and that it was significantly elevated in the postprandial and the fasting states in the Type 2 DM patients as compared to the levels in their respective control groups. This signified a routine estimation of the postprandial lipid profile, rather than the fasting lipid parameters, in the cardiovascular risk assessment in Type 2 DM.

KeyWords: Postprandial blood glucose (PBG), Cardiovascular disease (CVD), Waist-hip ratio (WHR)

INTRODUCTION

Type 2 Diabetes Mellitus (DM) is characterized by insulin resistance which is associated with glucose intolerance, hypertension, dyslipidaemia, a procoagulant state, and an increase in the microvascular and the macrovascular disease [1,2]. Diabetics are frequently hyperlipidaemic and they are at a high risk for coronary heart disease [3]. The high cardiovascular mortality which is associated with Type 2 DM is due to a prolonged, exaggerated, postprandial state [4,5]. The abnormal lipid profile in the postprandial state is more significant than the abnormal lipid profile in the fasting state in causing atherosclerotic complications in Type 2 diabetics [6-9]. Very few studies are available on the estimation of the postprandial lipid profile in Type 2 diabetic patients.

MATERIALS AND METHODS

The study population and its design

The present study was carried out on fifty Type 2 DM patients from the diabetic clinic or the indoor medicine wards and on fifty age and sex matched healthy controls, in the Department of Biochemistry, in collaboration with the Department of Medicine, Government Medical College and Hospital, Nagpur Maharashtra, India. The study group comprised of Diagnosed Type 2 DM patients. The patients who were on oral hypoglycaemic drugs, who had a duration of diabetes of more than five years and who were in the age group of 35-65 years, were only included in the study.

The patients with Type 1 DM, ages of less than 35 years and more than 65 years, renal failure, hepatic diseases, acute illnesses, recurrent myocardial infarction,unstable angina and a drug therapy that interfered with the serum lipid levels, were excluded from the study. This study was approved by the local ethical committee and before their participation; the patients and the volunteers were fully informed about the nature and the purpose of the study. Written consents were obtained from each of them. A majority of the patients had similar diets and lifestyles with regards to their daily exercise. The body weight and the height were recorded. The waist circumference and the hip circumference were measured and the WHR was calculated. A clinical examination, a urine examination, and a fundus examination were performed to assess the diabetic target organ damage.

LABORATORY ASSAYS

Under aseptic conditions, blood samples were drawn in the morning after an overnight (i.e. after 12 hours) fast and 6 hours after meals. The serum was separated from the blood cells by centrifugation within 30 minutes of the collection of the blood. The separated serum was analyzed for the following biochemical parameters:

- Serum total cholesterol byan enzymatic method and serum triglycerides (TGs) by an enzymatic method.
- Serum HDL cholesterol by phosphotungstate precipitation, followed by enzymatic method.
- Serum LDL Cholesterol and VLDL Cholesterol by using Friedewald's formula [10].

All the parameters were analyzed by using a semiautomatic analyzer (Transasia ERBA Chem-5Plus).

STATISTICAL ANALYSIS

In this case control study, all the statistical analyses were performed by using the "Graph Pad Prism 5" Software. The data was expressed as Mean ± SD. By using the Students unpaired't'-test, the statistical analysis was carried out to assess whether the differences between the Type 2 DM patients and the controls were significant and P values of <0.05 were considered as statistically significant.

RESULTS

We observed that the waist to hip ratios of the diabetic males and females were found to be statistically significant (p<0.05) as compared to those of their respective controls [Table/Fig-1]. We observed a significant increase in both the fasting and the postprandial blood glucose levels in the Type 2 Diabetic subjects, as compared to those of their respective controls. Also, the postprandial blood glucose level was significantly increased as compared to that in the fasting state in the Type 2 Diabetic subjects [Table/Fig-2].

We observed a significant increase in the serum total cholesterol (TC), triglycerides (TGs), the LDL-cholesterol levels in the fasting state in the Type 2 DM patients as compared to those in the control subjects (p<0.001). The HDL-cholesterol level was significantly decreased in the fasting state in the Type 2 DM patients as compared to that in the control subjects (p<0.001) [Table/Fig-3]. Also, we observed a significant increase in the serum total cholesterol (TC), triglycerides (TGs) and the LDL-cholesterol levels in the postprandial state in the Type 2 DM patients as compared to those in the control subjects (p<0.001). The HDL-cholesterol level was significantly decreased in the postprandial state in the Type 2 DM patients as compared to that in the control subjects (p<0.001) [Table/Fig-4].

We observed a significant increase in the serum total cholesterol (TC), triglycerides (TGs), the LDL-cholesterol levels in the postprandial state in the Type 2 DM patients as compared to their serum levels in the fasting state (p<0.001). The HDL-cholesterol level was significantly decreased in the postprandial state as compared to that in the fasting state in the Type 2 DM patients (p<0.001) [Table/Fig-5].

Subjects	Waist Hip Ratio (Mean + S.D.)		p value
	Controls (N=50)	Diabetics (N=50)	
Males	0.92 ± 0.035	0.96 ± 0.048	0.000
Females	0.83 ± 0.044	0.86 ± 0.048	0.036

[Table/Fig-1]: Waist hip ratio (WHR) in type 2 diabetic subjects and controls

Parameters	Normal Values (mg/dl)	Controls (N=50) (Mean ± Sd)	Diebetics (N=50) (Mean ± Sd)	p value by 't' test
Fasting Blood Glucose	< 100 mg/dl	90.60 ±13.38	185.00 ± 45.00	0.000*
Postprandial Blood Glucose	< 140 mg/dl	137.90 ± 21.12	235.40 ± 47.68	0.000*
p value by 't' test		0.000*	0.000*	

[Table/Fig-2]: Values of Fasting and Postprandial blood glucose levels in study group (Type 2 DM) and Controls

Fasting Serum Lipids	Normal Values (mg/dl)	Controls (n=50) (Mean + SD)	Diebetics (n=50) (Mean + SD)	p value by 't' test
Total Cholesterol (mg/dl)	200	156.50 ± 32.92	208.10 ± 53.18	0.000*
Triglycerides (mg/dl)	160	114.70 ± 34.17	171.70 ± 71.71	0.000*
HDL Cholesterol (mg/dl)	40	50.82 ± 6.05	45.72 ± 8.82	0.001#
LDL Cholesterol (mg/dl)	100	83.06 ± 33.58	128.80 ± 51.02	0.000*

*Significantly higher (p<0.001) as compared to control
#Significantly lower (p<0.001) as compared to control

[Table/Fig-3]: Values of various parameters of Fasting lipid profile in study group (Type 2 DM) and control group

Postprandial Lipids	Normal Values (mg/dl)	Controls (n=50) (Mean + SD)	Diebetics (n=50) (Mean + SD)	p value by 't' test
Total Cholesterol (mg/dl)	200	191.50 ± 36.38	238.90 ± 56.77	0.000*
Triglycerides (mg/dl)	160	139.50 ± 34.32	209.50 ± 74.48	0.000*
HDL Cholesterol (mg/dl)	40	41.88 ± 4.62	35.30 ± 7.25	0.000#
LDL Cholesterol (mg/dl)	100	121.50 ± 36.71	162.10 ± 53.26	0.000*

*Significantly higher (p<0.001) as compared to control
#Significantly lower (p<0.001) as compared to control

[Table/Fig-4]: Values of various parameters of Postprandial lipid profile in study group (Type 2 DM)

Serum Lipids Profile	Fasting Level (Mean + SD)	Postprandial (Mean + SD)	p value by 't' test
Total Cholesterol(mg/dl)	208.10 ± 53.18	238.90 ± 56.77	0.000*
Triglycerides(mg/dl)	171.70 ± 71.71	209.50 ± 74.48	0.000*
HDL Cholesterol(mg/dl)	45.72 ± 8.82	35.30 ± 7.25	0.000#
LDL Cholesterol(mg/dl)	128.80 ± 51.02	162.10 ± 53.26	0.000*

* Significantly higher (p<0.001) as compared to control.
# Significantly lower (p<0.001) as compared to control

[Table/Fig-5]: Values of various parameters of fasting and Postprandial lipid profile in study group (Type 2 DM)

DISCUSSION

In the present study, the postprandial lipid parameters i.e. TC, TGs and LDL-C were significantly increased in the Type 2 DM subjects as compared to the fasting lipid parameters and the postprandial HDL-C level was significantly decreased as compared to the fasting HDL-C level ($p<0.001$) [Table/Fig-5]. Also, the postprandial lipid parameters i.e. TC, TGs and LDL-C were significantly increased in the Type 2 DM subjects as compared to those in the control subjects [Table/Fig-4], which was in accordance with the results of previous studies.

Diabetes Mellitus (DM) is a group of metabolic diseases, which is characterized by chronic hyperglycaemia, which results from the defects in the insulin secretion, insulin action, or both. Type 2 Diabetes Mellitus (Type 2 DM), the most prevalent form of the disease, which is often asymptomatic in its early stages and it can remain undiagnosed for many years [11]. In Type 2 DM, the insulin resistance in the liver reflects the failure of the hyperinsulinaemia to suppress the gluconeogenesis, which results in fasting hyperglycaemia and a decreased glycogen storage by the liver in the postprandial state. Increased hepatic glucose production occurs early in the course of diabetes, though it is likely after the onset of the insulin secretory abnormalities and the insulin resistance in the skeletal muscle. As a result of the insulin resistance in the adipose tissue and obesity, the free fatty acid (FFA) flux from the adipocytes is increased, which leads to an increased lipid [very low density lipoprotein (VLDL) and TGs] synthesis in the hepatocytes. This is responsible for the dyslipidaemia which is found in Type 2 DM [elevated TGs, reduced HDL-C, and increased small dense low-density lipoprotein (LDL) particles [12].

This chronic hyperglycaemia of diabetes is associated with a long term damage, dysfunction and failure of various organs, especially the eyes, kidneys, nerves, heart and the blood vessels. The risk of the chronic complications increases as a function of the duration of the hyperglycaemia. Since Type 2 DM, often, has a long asymptomatic period of hyperglycaemia, many individuals with Type 2 DM have complications at the time of their diagnosis [13]. The macrovascular complications such as coronary heart disease and cerebrovascular disease are two to four times greater in the patients with Type 2 DM. Other factors (dyslipidaemia and hypertension) also play important roles in the macrovascular complications [14].

The postprandial dysmetabolism and the associated oxidative stress may link the insulin resistance and the Type 2 DM to the disproportional incidence of cardiovascular disease. Postprandial hypertrigly ceridaemia has been linked to asymptomatic and symptomatic macrovascular diseases in both normo- and hypertriglyceridaemic subjects and such abnormalities have been reported in the type 2 diabetics . The increased risk of atherosclerosis among them, may therefore, be related to the higher postprandial lipaemia in them. The earlier studies which were done in our institution, clearly demonstrate the presence of postprandial hypertriglyceridaemia among the diabetic subjects, irrespective of the fasting triglyceride levels [15].

Various studies have shown that postprandial dyslipidaemia is more important in the pathogenesis of the vascular changes and atherosclerosis and that it increases the risk of the cardiovascular events [16]. Though the importance of LDL cholesterol in the development of atherosclerosis has long been recognized, the increasing research attention over the past decades has been devoted to the heterogeneity of the LDL particles and the atherogenicity of the lipids and the lipoproteins which are other than LDL. A particularly atherogenic form of LDL includes the small, dense LDL particles and the oxidized LDL [17,18]. The postprandial dysmetabolism and the associated oxidative stress may link the insulin resistance and the Type 2 DM to the disproportional incidence of cardiovascular disease [19]. The high cardiovascular disease morbidity and the mortality which are associated with Type 2 DM is at least partly caused by a prolonged and an exaggerated postprandial state in these patients [20].

Hence, it is important to include the postprandial lipid profile estimation, in addition to the fasting lipid profile estimation, in the cardiovascular risk assessment in the patients with Type 2 DM.

CONCLUSIONS

Atherosclerosis is a postprandial phenomenon with respect to lipids, as we are in the postprandial phase for most of the day, with an additional adverse effect of the meal induced hyperglycaemia. The present study suggests that it is important to routinely estimate the postprandial lipid profile, in addition to the fasting lipid parameters, in the cardiovascular risk assessment in Type 2 DM. Thus, by rectifying the abnormal postprandial lipid parameters early in the course of diabetes, we can prevent the hazardous complications which are associated with Type 2 DM, the most common one being atherosclerotic coronary artery disease.

For lipids, the measurements which need to be used in the routine clinical practice and the clinically meaningful cut off values for the decision making, need to be established and more information regarding their clinical utility is needed. Further large scale studies are needed to elucidate the role of postprandial dyslipidaemia in the pathogenesis of accelerated atherosclerotic vascular disease, as well as the microangiopathic complications in the patients of Type 2 Diabetes mellitus.

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REFERENCES

[1] Alvin C. P. Screening for Type 2 Diabetes in: Diabetic care. *ADA*. Jan 2004; 27(1): 11-14.
[2] Harold EL. Type 2 Diabetes Mellitus: An overview. *Clinical Chemistry*. 1999;45(8): 1339-45.
[3] Maeda E, Yoshino G, Kasuga M. Diabetes mellitus as a risk factor for arteriosclerosis. *Nippon Rinsho*. 1993 Aug; 51(8): 2170-76.
[4] Tushuizen MF, Diamant M, Heine RJ. Postprandial dysmetabolism and cardiovascular disease in Type 2 Diabetes. *Postgrad Med J*. 2005; 81:1–6.
[5] Tentolouris N, Stylianou A, Lourida E, Perrea D et al. High postprandial triglyceridemia in patients with Type 2 Diabetes and microalbuminuria. *Journal of Lipid Research*. 2007; 48: 218-25.
[6] Axelsen M, Smith U, Eriksson JW, Jansson PA et al. Postprandial Hypertriglyceridemia and Insulin Resistance in Normoglycemic First-Degree Relatives of Patients with Type 2 Diabetes. *Ann Intern Med*. 1999; 131:27-31.
[7] Evans M, Anderson RA MB, Graham J, Gethin R et al. Ciprofibrate therapy Improves Endothelial Function and Reduces Postprandial Lipemia and Oxidative Stress in Type 2 Diabetes Mellitus. *Circulation*. 2000; 101:1773-79.

[8] Annuzzi G, Natale CD, Iovine C, Patti L, Rivellese A et al. Insulin resistance is independently associated with postprandial Alterations of triglyceride-rich lipoproteins in Type 2 Diabetes Mellitus. *Arterioscler Thromb Vasc Biol*. 2004; 24:2397-402.
[9] Ferreira AC. Postprandial hypertriglyceridemia increases circulating levels of endothelial cell Micro-particles. *Circulation*. 2004; 110:3599-603.
[10] Friedwald WT, Levy RL, Fredrickson DS. Estimation of the concentration of low density lipoprotein Cholesterol in plasma without use of the preparative ultracentrifuge. *Clinical chemistry*. 1972; 18(6): 499-502.
[11] Powers AC. Diabetes Mellitus in: Harrison's principle of Internal Medicine, 16th edition by Kasper, Hauser et al. Vol. 2, Chapter 323:2152-79.
[12] Kumar V, Madhu SV, Singh G, Gambhir JK. Post-Prandial Hypertriglyceridemia in Patients with Type 2 Diabetes Mellitus with and without Macrovascular Disease. *JAPI*. 2010; 58:603-07.
[13] Genovefa DK, Pilatis N, Kafaltis N, Sorodila K et al. Low fasting low high density lipoprotein and postprandial lipemia. *Lipids in Health and Disease.* 2004; 3:18.
[14] Rivellese AA, Natale CD, Marino LD, Patti L et al. Exogenous and endogenous postprandial lipid abnormalities in Type 2 Diabetic patients with optimal blood glucose control and optimal fasting triglyceride level. *Journal of Clinical Endocrinology and Metabolism*. 2004; 89(5):2153–59.
[15] Raj S, Rajsekheran C, Jaykumar B. Postprandial hypertriglyceridemia in Type 2 Diabetic subjects: *Int J of Diabetes in Developing Countries*. Dec 2006; 26(4); 160-62.
[16] Madhu SV, Mittal V, Ram BK, Srivastava DK et al. Postprandial lipid abnormalities in Type 2 diabetes Mellitus. *Journal of Associate Professors of India*. Dec 2005; 53:1043-46.
[17] Tushuizen MF, Diamant M, Heine RJ. Postprandial dysmetabolism and cardiovascular disease in Type 2 Diabetes. *Postgrad Med J.* 2005; 81:1–6.
[18] Enas A, Dhawan J, Petkar S et al. Coronary artery disease in Asian Indians lesson learnt and role of Lp-(a). *Indian Heart Journal.* 1997; 49: 25-34.
[19] Vasilios G. A, Konstantinos T, Asterios K and Dimitri P. M. Dyslipidaemia of Obesity, Metabolic Syndrome and Type 2 Diabetes Mellitus: the Case for Residual Risk Reduction After Statin treatment. *The Open Cardiovascular Medicine Journal*. 2011; 5: 24-34.
[20] Amrane N, Boumediene KM. Effect of Overweight and Obesity on Postprandial Lipemia among the Subjects with Type 2 Diabetes. *J Diabetes Metab.* 2012; 3:2:1-5.

AUTHOR(S):

1. Dr. Lokhande Suryabhan L
2. Dr. Iyer Chandrashekhar M
3. Dr. Shinde Ratnendra R
4. Dr. Nandedkar Prerna D

PARTICULARS OF CONTRIBUTORS:

1. Assistant Professor, Department of Biochemistry, Seth G.S. Medical College and K.E.M. Hospital Mumbai, India.
2. Professor, Department of Biochemistry, Government Medical College Nagpur, India.
3. Professor and Head, Department of PSM, Seth G.S. Medical College and Hospital, Mumbai, India.
4. Assistant Professor, Department of Biochemistry, Seth G.S. Medical College and K.E.M. Hospital Mumbai, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Lokhande Suryabhan L,
Assistant Professor, Department of Biochemistry,
Seth G.S. Medical College and K.E.M.
Hospital, Parel, Mumbai, 400012 India.
Phone: 918888865479; 918275782545
E-mail: lokhandesuryabhan@gmail.com

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