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Original Research Article

Lipoprotein(a) In Type 2 Diabetic Subjects and Its Relationship to Diabetic Microvascular Complications: A Cross-Sectional Study

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Abstract

Background: Diabetic microvascular complications have become a major cause of chronic kidney disease, blindness and diabetic foot problems, which are preventable to some extent. There has been a rising epidemic of diabetes mellitus in India in recent years and an alarming increase in the rate of mortality and morbidity due to coexisting dyslipidemia, atherosclerosis and coronary artery disease. The aim is to estimate the serum Lipoprotein (a) levels in type 2 diabetes mellitus patients and to determine if there is any relationship between serum Lp(a) levels and diabetic micro vascular complications.

Method: A cross sectional study was performed that enrolled 144 subjects with type 2 diabetes mellitus above the age of 25 years attending outpatient Department of General Medicine, RVM Medical College, Gajwel Siddipet, Telangana from April 2025 to September 2025. Lp(a) levels were measured quantitatively in venous samples using Turbidimetric Immunoassay in all subjects. Each patient was evaluated for micro vascular complications, namely diabetic retinopathy, nephropathy and neuropathy. The relationship between Lp(a) levels and the micro vascular complications was assessed by univariate analysis.

Results: Mean age of cases was 53.93 ± 10.74 years with a male to female ratio of 1.3:1. Mean duration of diabetes was 9.53 ± 7.3 years. Abnormal Lp(a) levels (≥ 30 mg/dL) were observed in 38 (26.4%) diabetic subjects. Seventy-eight (54.16%) cases had diabetic nephropathy and significantly higher Lp(a) levels were found among these cases [Median 28.2 mg/dL (Interquartile range; IQR 24.4-33.5) *vs* 19.3 mg/dL (IQR 14.7-23.5); $P< 0.05$]. Retinopathy was present among 66 (45.13%) cases and peripheral neuropathy was detected among 54 (37.5%) cases. However, Lp(a) levels were not significantly different among those with or without retinopathy and neuropathy. Positive correlation was found between higher Lp(a) levels and duration of diabetes ($r = 0.165$, $P < 0.05$) but not with HbA1c values ($r = – 0.083$).

Conclusion: Abnormal Lp(a) levels were found among 26.4% of diabetic subjects. Patients with diabetic nephropathy had higher Lp(a) levels. No association was found between Lp(a) levels and diabetic retinopathy or neuropathy. Longer duration of diabetes correlated with higher Lp(a) levels.

Keywords: Diabetes mellitus; Lipoprotein(a); Micro vascular complications; Diabetic nephropathy; Diabetic retinopathy; Diabetic neuropathy

Introduction

Diabetes mellitus is one of the most seen metabolic disorders which is characterized by hyperglycemia either due to insulin deficiency or insulin resistance.[1] Lipoprotein(a) [Lp(a)] is a low-density lipoproteinlike particle containing Apo-lipoprotein B 100 disulphide, linked to one large glycoprotein called Apo-Lp(a), a particle comprised of low-density lipoprotein and covalently bound Apo-Lp(a), and is considered a pro-atherogenic, pro-thrombotic risk factor for coronary heart disease (CHD).[1] Many prospective epidemiological studies have reported positive associations of baseline Lp(a) concentration with CHD risk. [2-4] It is associated with microvascular complications like diabetic nephropathy, Diabetic retinopathy, Diabetic neuropathy and macro-vascular complications like coronary artery disease, peripheral vascular disease etc. Because of these complications it is associated with increased morbidity as well as increased

mortality. It causes economic burden to the family as well as to society.[1]

Among all the Dyslipidemias associated with type 2 DM, elevated levels of serum lipoprotein(a) is of much importance because it is an important risk factor for atheromatous complications in diabetes than to non-diabetes.[4] Recently, much interest has been focused on Lp(a) which is a plasma complex composed of apolipoprotein(a) and Apo B -100. Because of structural similarities of Apo(a) to plasminogen, Lp(a) has been suggested to have antifibrinolytic properties.[5] The characteristic pattern of lipoproteins in type 2 diabetes mellitus includes an increase in Triglycerides, predominance of small dense LDL particles and decrease in HDL cholesterol.[1,3] In type 2 diabetes mellitus, insulin resistance reflects the failure of hyperinsulinemia to suppress the gluconeogenesis, which causes fasting hyperglycemia.[1] Lipoprotein (a) is a risk factor for the progression of diabetic nephropathy with overt proteinuria, arterial stiffness in elderly patient and peripheral arterial disease in type 2 DM patients.[2] Studies have conclusions that lipoprotein (a) is an independent risk factor for coronary artery disease and is a reliable predictor of coronary artery disease severity in type 2 diabetes mellitus patients.[6] There are conflicting reports on the relationship between Lp(a) levels and type 2 diabetes. Hyperinsulinemia tends to decrease Lp(a) levels among patients with type 2 diabetes, [5] and some studies even showed an inverse relationship between Lp(a) levels and incident type 2 diabetes. [6,7] However, some Asian studies showed a strong association between type 2 diabetes and elevated Lp(a) levels. [8,9] Similarly, there are conflicting reports on the evidence of association between Lp(a) levels and diabetic micro vascular complications like nephropathy, retinopathy and neuropathy. Therefore, the present study has been undertaken to assess the serum Lp(a) and the onset and progression of microvascular complications. In a study, Lp(a) levels were lower in subjects with hyperinsulinemia, [10] but in other studies, [11] no significant relation of Lp(a) to insulin was found. There is insufficient data from the Indian subcontinent on Lp(a) levels and its role in micro vascular complications among patients with type 2 DM.

Material and Methods

The study included patients with type 2 diabetes mellitus above the age of 25 years who were attending the medical and diabetic outpatient Department of General Medicine, RVM Medical College, Gajwel Siddipet, Telangana from April 2025 to September 2025. This study was planned with the following aims: (1) to estimate the level of serum Lp(a) in type 2 diabetes mellitus patients; and (2) to determine the relationship between Lp(a) levels and diabetic micro vascular complications. The exclusion criteria were: (1) patients who were already on lipid lowering drugs or glitazones and females taking oral contraceptive pills or hormone replacement therapy; (2) familial hypercholesterolemias; (3) hypothyroidism, including subclinical hypothyroidism (with thyroid stimulating hormone values above 5.5 μIU/mL); (4) those who are seriously ill and/or requiring hospitalization or with chronic liver or kidney disease with serum creatinine ≥ 2 mg%; and (5) those who were in the habit of alcohol use.

Subjects who were taking medications for hyperlipidemia or medications known to affect the lipid profile were excluded. Subjects with familial hyperlipidemia, pregnancy, hypothyroidism, alcoholism, as well as those with signs and/or symptoms of active infection or stressful conditions were excluded as they are known to alter the Lp(a) levels.

A detailed history including dietetic history was taken. Physical examination included height, weight and body mass index (BMI). BMI was calculated by determining weight in kilograms and dividing by the height in meters squared. Waist circumference was measured using a measuring tape in centimeters at the point where the mid axillary line touches the highest point of iliac crest. The plane of the tape was held parallel to the floor with the tape snug but without compression of the skin. The measurement was made at a normal minimal respiration.

Neuropathy assessment was done in both feet with vibration perception using a tuning fork of 128 Hz, elicitation of ankle jerks and testing with monofilament of 5.07 size (thickness), equivalent of 10 gm of linear force. If any two of the three tests were positive, the patient was considered to have neuropathy after excluding other causes for neuropathy with a reasonable clinical and appropriate laboratory evaluation. Examination of the retina was done through dilated pupils to determine the level of non-proliferative diabetic retinopathy, proliferative diabetic retinopathy (PDR) and macular edema by a qualified ophthalmologist. The definitions were based on the International Classification of Diabetic Retinopathy. Screening for microalbuminuria can be performed by measurement of the albumin-creatinine ratio in a random, spot collection (preferred method); the analysis of a spot sample for the albumin-creatinine ratio is strongly recommended by most authorities. In the present study, two of three specimens collected within a 3 to 6 mo period were used for quantification to include in the respective group.

A venous blood sample was collected after a 12 h overnight fasting for estimation of Lp(a) levels.

The measurement is performed with the person in a baseline stable condition. Lp(a) level was measured by turbidimetric immunoassay. The reference value for Lp(a) level in the normal population is < 30 mg/dL. HbA1c was estimated using high performance liquid chromatography method. Other laboratory investigations, including fasting and post prandial blood sugars, blood urea, serum creatinine and thyroid stimulating hormone, were done in all the patients.

Data are reported as median and inter quartile range (IQR) or mean ± SD for continuous variables and as proportions for categorical variables. Continuous variables were analyzed by *t*-test and Pearson's correlation when data was normally distributed and by Mann Whitney *U* test when data was not normally distributed. A *P* value < 0.05 was considered to indicate statistical significance. Statistical analysis was done using SPSS version 13.0 for Windows.

Results

A total of 144 subjects satisfying the inclusion criteria were included in the study. The mean age was 53.93 ± 10.74 years and the male to female ratio was 1.3:1. Mean duration of diabetes was 9.53 ± 7.3 years. Mean BMI was 25.16 ± 3.9 kg/m^2 with a waist circumference of 91.94 ± 8.8 cm. Mean systolic blood pressure was 134.12 ± 17.1 mmHg and mean diastolic blood pressure was 83.12 ± 9.2 mmHg. Mean HbA1c was 8.01% ± 2.15%. With regard to current diabetic management: 3% of patients were on diet alone; 70% were on oral antidiabetic drugs like metformin and/or sulfonylurea; 19% were on oral antidiabetic drugs (metformin and/or sulfonylurea) and insulin; and 8% were on insulin alone (Patients on glitazones were not included in the present study).

Lp(a) level was done in all 144 subjects (normal range in serum is up to 30 mg/dL). Lp(a) levels were abnormal in 38 (26.4%) cases and normal in 106 (73.6%) cases. Higher Lp(a) levels had a significant positive correlation to the duration of diabetes (r = 0.165; P < 0.05). However, Lp(a) levels did not have a correlation to HbA1c values (r = -0.083; P = insignificant).

Lp(a) levels and micro vascular complications: Retinopathy was assessed in all 144 patients. 78 (54.2%) did not have retinopathy. 66 (45.8%) cases had evidence of diabetic retinopathy, of whom 40 (27.8%) cases had mild non-proliferative retinopathy, 13 (9%) had moderate non-proliferative retinopathy and 8 (5.6%) had severe non-proliferative retinopathy. Five (3.4%) cases had PDR. There was no statistically significant difference in Lp(a) levels among patients with and without diabetic retinopathy (Table 1).

Table 1: Lipoprotein(a) levels among patients with or without retinopathy and neuropathy

	No. of cases	Lp(a) level (mg/dL)	
		Median	Inter quartile range
Retinopathy present	66	24.8	16.1-29.4
Retinopathy absent	78	22.9	14.9-27.6
Neuropathy present	54	23.2	18.1-27.3
Neuropathy absent	90	24.6	17.6-28.1

Lp(a): Lipoprotein(a).

Diabetic neuropathy was present in 54 (37.5%) patients and absent in 90 patients (62.5%) but there was no statistically significant difference in Lp(a) levels among patients with and without diabetic neuropathy.

Lp(a) levels and diabetic nephropathy: Seventy-eight (54.16%) cases had diabetic nephropathy (microalbuminuria or overt proteinuria). Median Lp(a) levels in this group was 28.2 mg/dL (IQR 24.4-33.5), whereas those without nephropathy had a median Lp(a) level of 19.3 mg/dL (IQR 14.7-23.5) and this difference was statistically significant (P < 0.05). Intergroup comparison of median Lp(a) levels between patients with microalbuminuria and macroalbuminuria also showed statistical significance (Table 2).

Table 2 : Definitions of abnormalities in albumin excretion and lipoprotein(a) levels with albumin-creatinine ratio

Albumin/creatinine ratio (µgm/mg creatinine)	No. of cases	Lp(a) levels (mg/dL)	
		Median	Inter quartile range
Normal (< 30)	66	19.3	14.7-23.5
Micro (30-299)[a,b]	58	26.4	20.2-32.8
Macroalbuminuria (≥ 300)[a]	20	33.2	30.3-36.1

[a]P < 0.05 *vs* normal; [b]P < 0.05 *vs* macroalbuminuria. Lp(a): Lipoprotein(a).

Discussion

Diabetes mellitus confers a two-fold higher risk for a wide range of vascular diseases, independent of other conventional risk factors[31]. Any additional risk factor along with diabetes would increase the vascular risk that might prove to be catastrophic to the sufferer. High Lp(a) level has been proven to be a risk factor for atherosclerosis and related morbidity and mortality in many studies[12-16]. It would be logical to consider higher vascular risk among diabetic patients with elevated Lp(a) levels although such an association is yet to be proven in controlled trials. Type 2 diabetics are usually hyperinsulinemic and insulin tends to lower the Lp(a) levels[17,18]. Large populationbased studies have even shown an inverse association between Lp(a) levels and incident diabetes[19,20]. However, some Asian studies clearly showed higher Lp(a) levels among type 2 diabetics[18,21,22]. These conflicting reports on the association between Lp(a) levels and type 2 diabetes prompted us to estimate the Lp(a) levels in this diabetic cohort. A significant proportion of type 2 diabetics (26.4%) had elevated Lp(a) levels, as observed by other workers[18,21,22]. Higher Lp(a) levels were observed among those with a longer duration of diabetes in this study, similar to the observations made by Habib et al[18]. Higher Lp(a) levels among patients with a longer duration of diabetes may be related to lower plasma insulin levels in such individuals. Because vascular risk is directly related to the duration of diabetes, the possible contribution of elevated Lp(a) levels to higher vascular risk among type 2 diabetics demands investigation in future clinical trials. A cross sectional analyses of two community-based studies showed that Lp(a) is a strong independent predictor of CHD risk in type-2 diabetic women, but not in men or in men or women without type-2 diabetes[32]. Already there is some evidence showing a strong association between peripheral occlusive arterial disease (a marker of systemic atherosclerosis) and serum Lp(a) levels in patients with diabetes[33]. The present study did not show any relationship of Lp(a) levels to glycemic control, as in one previous study[34]. The present study showed a statistically significant association between higher Lp(a) levels and diabetic nephropathy (both microalbuminuria and overt proteinuria). Tseng[24] from Taiwan also recently observed high Lp(a) levels among type 2 diabetic patients with overt proteinuria although an earlier study[23] did not show such an association. Our observation of high Lp(a) levels among those with overt proteinuria in the present study has important clinical implications as Lp(a) level is an independent risk factor for the progression of diabetic nephropathy in type 2 diabetic patients with overt proteinuria, as shown by Song et al[35]. We did not observe any statistically significant association between Lp(a) levels and diabetic retinopathy in this cohort. Some previous studies have shown an association between Lp(a) levels and retinopathy[25,26], while others have not[27,28]. Similar to the observations made by earlier workers[29,30], we were also unable to find any association between diabetic neuropathy Lp(a) levels. The small number of subjects selected for evaluation of a common clinical problem like type 2 diabetes mellitus is an important limitation of this study. However, the observation of high Lp(a) levels in a significant proportion of cases and the association between Lp(a) levels and diabetic nephropathy were especially noteworthy. Larger studies are necessary to elucidate the vascular risk related to Lp(a) levels in Indian patients with type 2 diabetes for strategic planning of preventive measures. In conclusion, Lp(a) levels were abnormal in 26.4% Lp(a) levels were abnormal in 26.4% of type 2 diabetic patients in the present study. A significantly higher proportion of patients with diabetic nephropathy had higher Lp(a) levels compared to those without nephropathy. Lp(a) levels were comparable among patients with or without diabetic retinopathy and diabetic peripheral neuropathy. A longer duration of diabetes had a positive correlation with higher Lp(a) levels. However, higher HbA1C levels did not have any correlation with Lp(a) levels.

Conclusion

In conclusion, Lp(a) levels were abnormal in 26.4% of type 2 diabetic patients in the present study. A significantly higher proportion of patients with diabetic nephropathy had higher Lp(a) levels compared to those without nephropathy. Lp(a) levels were comparable among patients with or without diabetic retinopathy and diabetic peripheral neuropathy. A longer duration of diabetes had a positive correlation with higher Lp(a) levels. However, higher HbA1C levels did not have any correlation with Lp(a) levels.

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