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Original Research Article

Evaluating the Correlation Between Serum Lipid Levels and Diabetic Retinopathy in Type 2 Diabetes Mellitus

Deeksha[1], Manoj Agarwal[2], Sharayu Kathar[3], Piyali Dutta Chowdhury[4]

[1]Post Graduate Researcher, Department of Ophthalmology, Mata Gujri Memorial Medical College & L.S.K. Hospital, Kishanganj, Bihar, India

[2]Associate Professor, Department of Ophthalmology, Mata Gujri Memorial Medical College & L.S.K. Hospital, Kishanganj, Bihar, India

[3]Post Graduate Researcher, Department of Ophthalmology, Mata Gujri Memorial Medical College & L.S.K. Hospital, Kishanganj, Bihar, India

[4]Assistant Professor, Department of Ophthalmology, Mata Gujri Memorial Medical College & L.S.K. Hospital, Kishanganj, Bihar, India

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Corresponding Author: Dr. Deeksha

Conflict of interest: Nil

Abstract:

Background: Diabetic retinopathy (DR) is a leading microvascular complication of type 2 diabetes mellitus (T2DM). Dyslipidemia has been implicated in its pathogenesis, but evidence remains inconsistent. This study explored the correlation between serum lipid levels and DR severity in T2DM patients.

Methods: Over the course of 18 months, in Kishanganj, Bihar, Mata Gujri Memorial Medical College and L.S.K. Hospital hosted this prospective observational study. A total of 250 T2DM patients aged ≥30 years underwent comprehensive ophthalmic examinations and fasting lipid profile assessments. DR was staged according to the Early Treatment Diabetic Retinopathy Study (ETDRS) criteria. Statistical analysis included ANOVA and Pearson's correlation.

Results: DR was present in 150 patients (60%). Among them, 90 (36%) had NPDR and 60 (24%) had PDR. Increasing severity of DR was associated with higher triglycerides, total cholesterol, and LDL cholesterol, while HDL cholesterol levels declined significantly ($p < 0.001$ for all). Pearson's correlation revealed strong positive associations between DR severity and total cholesterol ($r = 0.68$), triglycerides ($r = 0.62$), LDL cholesterol ($r = 0.65$), and a negative correlation with HDL cholesterol ($r = -0.57$).

Conclusion: Dyslipidemia is strongly linked with DR severity in T2DM patients. Routine monitoring and lipid management may delay the onset or progression of DR.

Keywords: Type 2 diabetes mellitus, Diabetic retinopathy, Dyslipidemia, Serum lipids.

Introduction

One of the most dangerous microvascular side effects of type 2 diabetes mellitus (T2DM) and a major contributor to visual impairment worldwide is diabetic retinopathy (DR). The pathogenesis involves prolonged hyperglycemia, leading to endothelial dysfunction, oxidative stress, inflammatory cascades, and microvascular compromise of the retina. These processes damage the blood-retinal barrier, resulting in vascular leakage and progressive retinal injury.

Dyslipidemia, defined by lowered HDL cholesterol and increased LDL, total, and triglyceride cholesterol, is well recognized as a cardiovascular risk factor. However, its contribution to microvascular complications, especially DR, remains under investigation. Some studies have shown strong associations between lipid abnormalities and DR development, particularly with retinal exudates and edema, whereas others report weaker or inconsistent links.

Clarifying this association has important clinical implications. Early detection and control of dyslipidemia could be integrated into DR prevention strategies. Lipid-lowering therapies, such as statins and fibrates, already widely used in diabetes management, may also protect retinal integrity. The purpose of study to evaluate the relationship between serum lipid levels and DR presence and severity in T2DM patients.

Materials and Methods

Study Design and Setting: Over the course of 18 months in Kishanganj, Bihar, Mata Gujri Memorial

Medical College and L.S.K. Hospital hosted this prospective observational study.

Sample Size and Participants: A total of 250 patients aged ≥30 years with a confirmed diagnosis of T2DM were enrolled.

Inclusion Criteria:

- Age ≥30 years
- Diagnosed T2DM patients
- Provided informed consent

Exclusion Criteria:

- T1DM
- Pre-existing ocular diseases affecting the retina
- Prior use of lipid-lowering therapy
- Systemic conditions influencing lipid metabolism or retinal status

Data Collection: Age, sex, and length of diabetes were among the demographic information that was documented. Slit-lamp biomicroscopy, dilated fundus examination, and visual acuity testing were all part of the ophthalmic examinations.

Classification of Diabetic Retinopathy: Staged according to ETDRS criteria: no DR, non-proliferative DR (NPDR: mild, moderate, severe), and PDR.

Laboratory Investigations: Fasting lipid profiles using common enzymatic assays, (total cholesterol, triglycerides, LDL-C, and HDL-C) were assessed.

Statistical Analysis: Data were analyzed using ANOVA and Pearson's correlation. $p < 0.05$ was considered statistically significant.

Results

Demographics:

- Mean age: 55.4 ± 8.7 years
- Male-to-female ratio: 1.3:1
- Mean diabetes duration: 8.2 ± 4.5 years

Prevalence of DR:

- DR present in 150 patients (60%)
- No DR: 100 patients (40%)
- NPDR: 90 patients (36%) → Mild (16%), Moderate (12%), Severe (8%)
- PDR: 60 patients (24%)

Serum Lipids and DR Severity:

Lipid Parameter	No DR (n=100)	NPDR (n=90)	PDR (n=60)	p-value
Total Cholesterol (mg/dL)	180.5 ± 24.3	210.7 ± 29.5	238.9 ± 35.6	<0.001
Triglycerides (mg/dL)	130.2 ± 20.7	165.8 ± 30.1	192.4 ± 38.2	<0.001
LDL Cholesterol (mg/dL)	102.4 ± 18.9	128.6 ± 24.7	152.3 ± 27.9	<0.001
HDL Cholesterol (mg/dL)	46.8 ± 7.6	39.5 ± 6.2	34.1 ± 5.4	<0.001

Correlation Analysis:

- Total cholesterol: $r = 0.68$, $p < 0.001$
- LDL cholesterol: $r = 0.65$, $p < 0.001$
- HDL cholesterol: $r = -0.57$, $p < 0.001$
- Triglycerides: $r = 0.62$, $p < 0.001$

Discussion

This study highlights a clear relationship between serum lipid abnormalities and the severity of DR in individuals with T2DM. Higher concentrations of triglycerides, total cholesterol, and LDL-C were associated with more advanced stages of retinopathy, while HDL-C demonstrated a protective effect. These findings indicate that lipid disorders may not only contribute to cardiovascular risk but also play a significant role in microvascular complications such as DR.

Our observations are in line with several large-scale investigations that reported similar associations. The Wisconsin Epidemiologic Research and Prompt Management of Diabetic Retinopathy Both studies found that high lipid levels correlated with retinal hard exudates, a key feature of DR progression. More recent studies, such as those by Santos and colleagues, also confirmed that raised LDL-C and triglycerides, along with reduced HDL-C, increased the likelihood of retinopathy. Importantly, randomized clinical trials including the FIELD study have demonstrated that lipid-lowering medications, particularly fenofibrate, reduced the need for laser therapy in DR patients, suggesting that lipid control may have therapeutic benefits beyond cardiovascular health.

There are biologically plausible mechanisms to explain these associations. Excess LDL-C and triglycerides can promote endothelial dysfunction, oxidative stress, and chronic inflammation, all of which impair the integrity of retinal capillaries. Damage to the blood–retinal barrier allows lipids and proteins to leak into the retinal tissue, leading to exudate formation and edema. In contrast, HDL-C exerts protective effects by reducing oxidative damage, improving endothelial function, and mediating reverse cholesterol transport. The imbalance between these lipid fractions therefore accelerates retinal injury and contributes to the worsening of retinopathy.

Not all studies, however, have reported strong correlations between serum lipids and DR. For instance, Funatsu and colleagues found that

glycemic control and duration of diabetes remained stronger predictors of retinopathy than lipid levels. Such differences may arise from variations in study design, patient characteristics, or methods of lipid assessment. Ethnic background, genetic predisposition, and lifestyle factors such as diet and smoking may further explain inconsistencies across populations. These discrepancies highlight the complex, multifactorial nature of DR, where lipids act as one of several contributing elements.

The strengths of the present study include its prospective design, the use of standardized criteria (ETDRS) to classify retinopathy, and the evaluation of multiple lipid parameters in a reasonably sized patient cohort. Nevertheless, some limitations must be acknowledged. As an observational study, it cannot establish causality. Important confounding variables, such as glycemic indices, blood pressure, and medication history, were not fully accounted for. Moreover, the single-center setting in Bihar may restrict the findings' generalizability to people or geographical areas with distinct genetic and environmental origins.

In summary, this research reinforces the view that dyslipidemia is closely linked to the development and PDR. While good glycemic control remains essential, attention to lipid abnormalities should be integrated into comprehensive diabetes management. Regular lipid monitoring and timely intervention with lifestyle changes or pharmacological agents could help reduce the risk or delay the onset of retinopathy. Future multicenter, longitudinal, and interventional studies are required to confirm these associations and to determine the most effective lipid-lowering strategies for protecting vision in people with diabetes.

Conclusion

This study highlights a clear correlation between dyslipidemia and DR in T2DM patients. Elevated cholesterol, triglycerides, and LDL, along with reduced HDL, significantly increase the risk and severity of DR. Incorporating lipid monitoring and management into routine diabetes care may reduce the burden of retinopathy.

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