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Research Article

# Correlation Of Diabetic Retinopathy With Hypertension And Dyslipidaemia In Patients With Type 2 Diabetes Mellitus

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## ABSTRACT

**Introduction:** Diabetes is a huge and growing problem, and the costs to society are high and escalating. The prevalence of diabetes mellitus is growing rapidly worldwide and is reaching epidemic proportions. It is estimated that there are currently 382 million people have diabetes worldwide. About 80% live in low- and middle-income countries. If these trends continue, by 2035, some 592 million people or one adult in 10 will have diabetes. Diabetic retinopathy is one of the complications of uncontrolled diabetes. It occurs due to the microvascular changes in retina which leads to ischemia. The rate of development of micro vascular changes depends on the blood sugar levels and duration of the disease. Glucose toxicity is a key trigger for diabetic retinopathy. Objectives of the study was to find the association of diabetic retinopathy with dyslipidemia and hypertension and to determine the role of dyslipidemia and hypertension in progression of diabetic retinopathy.
**Results:** Around half of them belonged to the age group of 60-69 years, followed by 51-59 years (24%). Around 18% belonged to age group of >70 years. Around 10% were of age less than 50 years with equal number of males and females. Approximately 12% had PDR and normal retinopathy findings each in both the eyes. 48.38% had NPDR findings in both the eyes. It was observed that as the duration of diabetes is increasing the chances of developing diabetic retinopathy are significantly high with P value of 0.00003. The association of blood sugar levels and development of diabetic retinopathy are significantly high. HbA1C was also significantly associated with diabetic retinopathy. Blood pressure levels and lipid levels were significantly associated with severity of retinopathic changes.
**Conclusion:** The study concluded that blood pressure levels, lipid levels increase the severity of diabetic retinopathy..

***Keywords****: Diabetes Mellitus, Diabetic Retinopathy, hypertension, dyslipidaemia.*

## INTRODUCTION

Diabetic retinopathy (DR) is a major microvascular complication of diabetes mellitus and a leading cause of vision impairment globally. It is primarily associated with prolonged hyperglycemia, but other systemic factors such as hypertension and dyslipidemia have been implicated in its progression and severity. The increasing prevalence of type 2 diabetes mellitus (T2DM) has led to a corresponding rise in DR cases, making it a critical public health concern[1].

Hypertension plays a crucial role in the pathogenesis of DR by exacerbating endothelial dysfunction and increasing vascular permeability, leading to retinal microvascular damage[2]. Studies have demonstrated that elevated blood pressure is strongly associated with the severity and progression of DR, emphasizing the importance of blood pressure control in diabetic patients[3]. Similarly, dyslipidaemia contributes to DR development through lipid deposition in retinal vessels,

promoting inflammation and oxidative stress[4]. Increased levels of total cholesterol and low-density lipoprotein (LDL) have been linked to the formation of hard exudates and macular edema, further aggravating retinal damage[5].

Given the interrelated pathophysiology of DR, hypertension, and dyslipidemia, understanding their correlation is crucial for improving screening strategies and management approaches in T2DM patients. Hence this study was conducted with the objectives to determine the correlation of hypertension and dyslipidemia with diabetic retinopathy in patients with Type 2 diabetes mellitus at a tertiary care center.

## MATERIAL AND METHODS

The study was conducted in the ophthalmology outpatient department at a tertiary care center as a hospital-based cross-sectional study from November 2019 to October 2021. The study population included all clinically diagnosed type 2 diabetes mellitus patients undergoing regular treatment who presented with diabetic retinopathy. A purposive sampling technique was used. The sample size was calculated based on a prevalence of 3.5% reported by **Elagamy A et al.,**[6] using a confidence level of 95% and a precision of 5%, yielding a minimum sample size of 52, which was adjusted to 62 after considering a 20% non-response rate.

Patients meeting the inclusion criteria were enrolled after obtaining informed consent. The inclusion criteria consisted of patients with type 2 diabetes mellitus who were willing to participate, while exclusion criteria included those with previous ocular trauma, lens-induced glaucoma, secondary or complicated cataract, anterior uveitis, gestational diabetes, type 1 diabetes mellitus, unclear media preventing fundus examination, severe illness or debilitation, pregnancy or lactation, and those unwilling to provide informed consent. Ethical approval was obtained from the Institutional Ethics Committee. All enrolled participants underwent clinical evaluation for diabetic retinopathy, hypertension, and dyslipidemia. The assessments included slit-lamp examination, fundoscopy using direct ophthalmoscopy, 90D lens, and indirect ophthalmoscopy, along with blood investigations such as random blood sugar (RBS), fasting blood sugar (FBS), postprandial blood sugar (PPBS), and HbA1C.[7] Blood pressure was measured three times over six hours, with the mean value recorded. Lipid profile tests were also performed.[8] Data was entered into Microsoft Excel 2010 and analyzed using Microsoft Excel 2010 and Epi Info 7.2.0. Descriptive and inferential statistical analyses were employed, with continuous variables presented as Mean ± SD (Min-Max) and categorical variables as numbers and percentages. The significance level was set at 5%. Student's t-test was applied for continuous variable comparison, while. Categorical data were analyzed using the chi-square test with a 95% confidence interval.

## RESULTS

The study included 62 participants, with an equal distribution of males and females (50% each) (Table 1). The majority of the study population was aged between 60-69 years (48.38%), followed by 51-59 years (24.19%), while only 9.67% were ≤50 years old. Most participants had diabetes for 10-14 years (61.29%), with 20.96% having a duration of 5-9 years and 17.74% for ≥15 years. The glycaemic profile of the study population showed that 88.70% had random blood sugar levels >160 mg/dl, 53.22% had fasting blood sugar levels >126 mg/dl, and 75.80% had postprandial blood sugar levels >200 mg/dl. HbA1C levels were between 6.7-7% in 67.74% of patients, 7.1-7.9% in 22.58%, and ≥8% in 9.67% (Table 2). Regarding blood pressure, 54.83% of the study population had systolic blood pressure ≥140 mmHg, while 25.80% had ≤120 mmHg. Diastolic blood pressure was ≤80 mmHg in 29.03%, 81-89 mmHg in 43.54%, and ≥90 mmHg in 25.41% (Table 3). The lipid profile assessment revealed that 72.58% of participants had total cholesterol levels >200 mg/dl, 67.74% had triglycerides >150 mg/dl, and 70.96% had LDL levels >140 mg/dl. All participants had HDL levels >40 mg/dl (Table 4). Retinopathy findings showed that in the right eye, 11.29% had no diabetic retinopathy, while 22.58% had mild NPDR, 16.12% had moderate NPDR, 24.19% had severe NPDR, and 25.8% had PDR. In the left eye, 12.90% had no diabetic retinopathy, 12.90% had mild NPDR, 30.64% had moderate NPDR, 20.96% had severe NPDR, and 22.58% had PDR (Table 5). In Overall study population, 11.29% had PDR and normal retinopathy findings in both the eyes. 48.38% had NPDR findings in both the eyes.

**Table 1: Profile of study population**

| | | Frequency (n =62) | Percentage |
|---|---|---|---|
| Age (years) | ≤50 years | 6 | 9.67% |
| | 51-59 years | 15 | 24.19% |
| | 60-69 years | 30 | 48.38% |
| | >70 years | 11 | 17.74% |
| Gender | Male | 31 | 50% |
| | Female | 31 | 50% |
| Duration of diabetes (years) | 5-9 years | 13 | 20.96% |
| | 10-14 years | 38 | 61.29% |
| | ≥15 years | 11 | 17.74% |

**Table 2: Glycaemic profile of subjects in the study**

| | | Frequency (n = 62) | Percentage |
|---|---|---|---|
| Random Blood Sugar (mg/dl) | ≤160 | 7 | 11.29% |
| | >160 | 55 | 88.70% |
| Fasting Blood Sugar (mg/dl) | ≤126 | 29 | 46.77% |
| | > 126 | 33 | 53.22% |
| Post Prandial Blood Sugar (mg/dl) | ≤ 200 | 15 | 24.19% |
| | > 200 | 47 | 75.80% |
| $HbA_1C$ | 6.7-7% | 42 | 67.74% |
| | 7.1-7.9% | 14 | 22.58% |
| | ≥8% | 6 | 9.67% |

**Table 3: Blood pressure among study population**

| | | Frequency | Percentage |
|---|---|---|---|
| Systolic Blood Pressure (mmHg) | ≤120 | 16 | 25.80% |
| | 121-139 | 12 | 19.35% |
| | ≥140 | 34 | 54.83% |
| Diastolic Blood Pressure (mmHg) | ≤80 | 18 | 29.03% |
| | 81-89 | 27 | 43.54% |
| | ≥90 | 17 | 25.41% |

**Table 4: Lipid profile among study population**

| | | Frequency | Percentage |
|---|---|---|---|
| Total Cholesterol in mg/dl | ≤200 | 17 | 27.41% |
| | >200 | 45 | 72.58% |
| Total triglycerides (mg/dl) | ≤150 | 20 | 32.25% |
| | >150 | 42 | 67.74% |
| Low density lipoproteins (LDL) mg/dl | ≤140 | 18 | 29.03% |
| | >140 | 44 | 70.96% |
| High density lipoprotein (HDL) mg/dl | ≤40 | 0 | 0 |
| | >40 | 62 | 100 |

**Table 5: Retinopathy findings of both eyes**

| | **Right Eye** | | **Left Eye** | |
|---|---|---|---|---|
| | **Frequency** | **Percentage** | **Frequency** | **Percentage** |
| No Diabetic Retinopathy | 7 | 11.29 | 8 | 12.90 |
| Mild NPDR | 14 | 22.58 | 8 | 12.90 |
| Moderate NPDR | 10 | 16.12 | 19 | 30.64 |
| Severe NPDR | 15 | 24.19 | 13 | 20.96 |
| PDR | 16 | 25.8 | 14 | 22.58 |

**Table 6: Comparison of parameters with respect to Type of Diabetic Retinopathy**

| **Parameter** | **No DR(n=7)** | **NPDR(n=30)** | **PDR(n=7)** | **P value** |
|---|---|---|---|---|
| Age in years | 57.57±6.77 | 63.41±7.60 | 61.85±4.94 | 0.100 |
| Duration of diabetes in years | 8.71±2.92 | 10.87±2.90 | 13.28±3.25 | 0.00003** |
| RBS in mg/dl | 209.42±21.59 | 178.54±23.22 | 217.71±23.6 | 0.0001** |
| FBS in mg/dl | 141.57±8.82 | 119.19±14.22 | 148.0±18.43 | 0.000008** |
| PLBS in mg/dl | 300.85±26.25 | 243.41±48.36 | 290.57±47.47 | 0.003** |
| $HbA_1C$ | 6.88±0.106 | 6.98±0.35 | 7.28±0.3 | 0.01** |
| Systolic Blood Pressure (mmHg) | 128.57±19.10 | 138.32±18.28 | 154.85±19.52 | 0.03** |
| Diastolic Blood Pressure (mmHg) | 80.8±9.78 | 84.3±9.41 | 95.28±7.52 | 0.01** |
| Total cholesterol (mg/dl) | 221.42±32.36 | 230.77±36.93 | 286.14±25.47 | 0.001** |
| Triglycerides (mg/dl) | 144.85±47.61 | 174.93±52.46 | 218.8±28.06 | 0.02** |
| Low density Lipoproteins (mg/dl) | 138.57±22.9 | 148.83±26.22 | 190.85±22.9 | 0.0004** |
| High Density Lipoproteins (mg/dl) | 51.71±546 | 47.85±2.96 | 36.4±7.10 | 0.0000003** |

The comparison of parameters with respect to the type of diabetic retinopathy revealed significant differences in several variables (Table 6). The mean age of patients did not show a statistically significant difference among groups (p=0.100). However, the duration of diabetes was significantly higher in patients with PDR (13.28±3.25 years) compared to NPDR

(10.87±2.90 years) and no DR (8.71±2.92 years) (p=0.00003). RBS, FBS, and PLBS levels were significantly elevated in patients with PDR (217.71±23.6 mg/dl, 148.0±18.43 mg/dl, and 290.57±47.47 mg/dl, respectively) compared to NPDR and no DR (p<0.01). HbA1C levels also showed a significant increase in PDR cases (7.28±0.3) compared to NPDR (6.98±0.35) and no DR (6.88±0.106) (p=0.01). Blood pressure parameters were significantly higher in PDR cases, with systolic blood pressure at 154.85±19.52 mmHg and diastolic blood pressure at 95.28±7.52 mmHg (p=0.03 and p=0.01, respectively). Lipid profile analysis demonstrated that total cholesterol (286.14±25.47 mg/dl), triglycerides (218.8±28.06 mg/dl), and LDL (190.85±22.9 mg/dl) levels were significantly higher in PDR cases compared to NPDR and no DR (p<0.02). In contrast, HDL levels were significantly lower in PDR patients (36.4±7.10 mg/dl) compared to NPDR (47.85±2.96 mg/dl) and no DR (51.71±5.46 mg/dl) (p=0.0000003). These findings highlight a strong correlation between diabetic retinopathy severity and poor glycemic control, hypertension, and dyslipidemia.

## DISCUSSION

The findings of this study provide valuable insights into the relationship between diabetic retinopathy (DR) and various metabolic and cardiovascular parameters, including glycemic control, blood pressure, and lipid profile. Our results indicate a significant correlation between poor glycemic control, hypertension, and dyslipidemia with the severity of DR. This aligns with several previous studies that have examined the interplay between these factors and DR progression.

A critical determinant of DR is the duration of diabetes, as shown in our study where patients with proliferative diabetic retinopathy (PDR) had a significantly longer diabetes duration compared to those with non-proliferative diabetic retinopathy (NPDR) and no DR. This observation is supported by **Elagamy et al.[6]** who documented a statistically significant relationship between diabetes duration and DR severity. The metabolic insult associated with prolonged hyperglycemia leads to endothelial dysfunction, microvascular damage, and increased retinal vascular permeability, contributing to DR progression.

Our study demonstrated that glycemic control, as assessed by fasting blood sugar (FBS), postprandial blood sugar (PLBS), and HbA1c, was significantly poorer in patients with DR. This observation is consistent with findings by **Pan et al.[9]** who reported that poor glycemic control was a major risk factor for DR, with HbA1c levels >7% being associated with increased likelihood of developing retinopathy.[9] The Diabetes Control and Complications Trial (DCCT) has also confirmed that tight glycemic control reduces the risk of DR development and progression.[9]

Hypertension is another independent risk factor for DR, as our study indicated a significant association between elevated systolic and diastolic blood pressure and the severity of DR. This concurs with **Waris et al.[10]** who found that 53.33% of DR patients had hypertension, with a higher prevalence in those with severe NPDR and PDR. The United Kingdom Prospective Diabetes Study (UKPDS) has established that blood pressure control significantly reduces the risk of DR progression.[10] Hypertension exacerbates retinal damage by increasing shear stress on the retinal microvasculature, leading to endothelial dysfunction and retinal ischemia. Jain R et al showed hypertension is an independent predisposing factor in causation and progression of diabetic retinopathy.[11]

Dyslipidemia was notably associated with DR severity in our study. Patients with PDR exhibited significantly higher levels of total cholesterol, triglycerides, and LDL, while HDL levels were significantly lower. **Zhou et al.[12]** conducted a meta-analysis that demonstrated a mild but significant increase in LDL levels among DR patients, supporting our findings. However, the role of dyslipidemia in DR progression remains controversial, with some studies suggesting a weak or inconsistent association. The Early Treatment Diabetic Retinopathy Study (ETDRS) reported that elevated serum lipids were associated with hard exudates but not necessarily DR progression.[12] Nevertheless, **Elagamy et al.[6]** found a significant correlation between elevated LDL and decreased HDL levels with DR and diabetic macular edema (DME), reinforcing the need for lipid management in diabetic patients.

Fenofibrate, a lipid-lowering agent, has been found to reduce DR progression, particularly in patients with DME, as highlighted in the FIELD and ACCORD studies.[12] This suggests that lipid control may have therapeutic benefits in preventing DR complications.

Our study supports the hypothesis that the combination of poor glycemic control, hypertension, and dyslipidemia contributes synergistically to DR pathogenesis. This is further validated by **Pan et al.,** who demonstrated that simultaneous control of blood pressure and glycemia significantly reduces DR risk.[9] Tharaheshwari et al.[13] concluded lipid profile i.e., TG and VLDL level was increased significantly. The cholesterol/ HDL ratio was found to be higher in diabetic patients with hypertension where as it was within the normal range in non-diabetic patients with hypertension. Effective management strategies should include lifestyle interventions, optimal glycemic control, blood pressure regulation, and lipid-lowering therapy.

## CONCLUSION

This study highlights the significant association of diabetic retinopathy with hypertension and dyslipidemia in patients with type 2 diabetes mellitus. The findings indicate that a longer duration of diabetes, poor glycemic control, elevated blood pressure, and abnormal lipid profiles contribute to the progression of diabetic retinopathy. Patients with

proliferative diabetic retinopathy had higher random blood sugar, fasting blood sugar, and postprandial blood sugar levels compared to those with non-proliferative diabetic retinopathy or no diabetic retinopathy, emphasizing the role of poor glycemic control in disease severity. Increased systolic and diastolic blood pressure were observed in patients with severe diabetic retinopathy, reinforcing the impact of hypertension on retinal microvascular complications. Similarly, elevated total cholesterol, triglycerides, and LDL levels were significantly associated with the severity of diabetic retinopathy, while lower HDL levels were more prevalent in patients with proliferative diabetic retinopathy. These findings suggest that dyslipidemia plays a crucial role in the pathogenesis and progression of diabetic retinopathy.

**Recommendations**

Regular screening for diabetic retinopathy should be emphasized, particularly in patients with a longer duration of diabetes, poor glycemic control, hypertension, and dyslipidemia. Strict glycemic control with target HbA1C levels below 7% should be encouraged to reduce the risk of retinopathy progression. Additionally, blood pressure management should be prioritized, with a focus on maintaining systolic blood pressure below 140 mmHg and diastolic blood pressure below 90 mmHg through lifestyle modifications and appropriate antihypertensive therapy. Dyslipidemia management, including dietary changes, physical activity, and lipid-lowering medications, should be reinforced, particularly in patients with elevated LDL and total cholesterol levels. Early intervention through a multidisciplinary approach involving ophthalmologists, endocrinologists, and primary care physicians is crucial for preventing complications associated with diabetic retinopathy.

Despite these valuable insights, the study has certain limitations. The relatively small sample size (n=62) may limit the generalizability of the findings to larger populations. Additionally, the cross-sectional design prevents the establishment of a causal relationship between hypertension, dyslipidemia, and diabetic retinopathy progression. The use of purposive sampling may introduce selection bias, affecting the external validity of the results. Furthermore, other potential confounding factors, such as genetic predisposition, lifestyle habits, and medication adherence, were not accounted for in the study. Diabetic maculopathy (DME), vitreous haemorrhage and other complications of diabetes retinopathy, as the severe stage of disease, type of treatment (oral hypoglycaemic drugs, injectable insulin) were not included in the study. Future longitudinal studies with larger sample sizes and diverse populations are recommended to further explore these associations and strengthen the evidence for targeted interventions.

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