

Analysis of Risk Factors of Diabetic Retinopathy: An Institutional Based Study

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Article History

Received: 08 May 2015

Revised: 24 May 2015

Accepted: 17 Jun 2015

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ABSTRACT

Background: Diabetic retinopathy is an important microvascular complication of diabetes mellitus and a major cause of preventable visual impairment. Its development is influenced by multiple demographic, metabolic, systemic, and renal risk factors. Identification of these factors is essential for early detection and prevention of disease progression.

Aim: To analyze risk factors of diabetic retinopathy.

Materials and Methods: This hospital-based observational clinical study included 105 patients with diabetes mellitus. Detailed demographic, clinical, systemic, biochemical, and ophthalmological assessments were performed. Parameters evaluated included age, sex, type and duration of diabetes, body mass index, treatment modality, hypertension, smoking, dyslipidaemia, glycaemic status, renal dysfunction, and albuminuria/proteinuria. Diabetic retinopathy was graded according to standard clinical criteria. Statistical analysis included appropriate comparative tests and multivariable logistic regression, with $p < 0.05$ considered statistically significant.

Results: Diabetic retinopathy was present in 58 (55.24%) patients, while 47 (44.76%) had no apparent retinopathy. Mild, moderate, severe non-proliferative diabetic retinopathy and proliferative diabetic retinopathy were present in 19.05%, 15.24%, 11.43%, and 9.52% of patients, respectively. Diabetic macular oedema was observed in 17.14%. Significant associations were noted with age > 60 years, diabetes duration > 10 years, HbA1c $\geq 7.0\%$, hypertension, dyslipidaemia, obesity, renal dysfunction, and albuminuria/proteinuria. On multivariable analysis, duration of diabetes > 10 years (AOR 3.64), HbA1c $\geq 7.0\%$ (AOR 3.28), hypertension (AOR 2.46), and albuminuria/proteinuria (AOR 2.87) remained significant independent risk factors.

Conclusion: Diabetic retinopathy was frequent among diabetic patients and was strongly associated with prolonged diabetes, poor glycaemic control, hypertension, and renal involvement. Regular retinal screening and optimal management of modifiable systemic risk factors are essential to reduce progression and vision-threatening complications.

KEYWORDS: Diabetic Retinopathy; Diabetes Mellitus; HbA1c; Hypertension; Albuminuria.

INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycaemia resulting from defects in insulin secretion, insulin action, or both. With prolonged disease, sustained metabolic abnormalities can damage small and large blood vessels and produce complications involving the eyes, kidneys, nerves, heart, and peripheral circulation. Diabetic

retinopathy is one of the most important microvascular complications of diabetes and remains a major cause of preventable visual impairment among adults. Retinal changes may remain asymptomatic for a considerable period, making systematic ocular evaluation essential even when visual acuity appears satisfactory. Population-based studies have emphasized the importance of identifying diabetic individuals at risk of

retinal involvement for appropriate surveillance and timely management.¹ Diabetic retinopathy develops through a complex interaction between chronic hyperglycaemia, retinal microvascular injury, endothelial dysfunction, capillary leakage, vascular occlusion, and tissue hypoxia. Early retinal lesions include microaneurysms, retinal haemorrhages, hard exudates, and cotton-wool spots. Progressive damage may lead to venous abnormalities, intraretinal microvascular abnormalities, retinal ischaemia, and neovascularization. Depending on the extent of these changes, diabetic retinopathy is categorized into non-proliferative and proliferative stages. Diabetic macular oedema may occur at different stages and can compromise central vision. Because retinal disease may progress with few ocular symptoms, regular retinal examination remains an important component of diabetes care.² The development and progression of diabetic retinopathy are influenced by several systemic and metabolic factors. Duration of diabetes and the degree of glycaemic exposure are among the most consistently recognized determinants. Persistent elevation of blood glucose promotes structural and biochemical alterations within the retinal microcirculation, while inadequate long-term glycaemic control accelerates microvascular injury. Glycated haemoglobin is an important measure of chronic glycaemic exposure and is useful when evaluating the risk profile of patients with diabetes. Assessment of HbA1c together with fasting and postprandial blood glucose provides a broader picture of metabolic control.³ Hypertension is another important systemic factor in diabetic patients. Elevated blood pressure may increase stress on an already compromised retinal microvasculature and contribute to worsening retinal vascular abnormalities. Blood pressure evaluation should therefore form part of routine risk assessment in individuals undergoing screening for diabetic retinopathy. Age, age at diagnosis, type of diabetes, treatment requirements, and duration of metabolic exposure may further modify risk. Identifying these variables is important because patients with similar glycaemic status may not have the same likelihood of retinal disease progression.⁴ Renal involvement is closely linked with diabetic microvascular disease. Albuminuria and renal dysfunction reflect systemic microvascular injury and may coexist with retinal vascular abnormalities. Assessment of urinary albumin excretion, proteinuria, serum creatinine, and renal function can therefore provide additional information in patients with diabetic retinopathy. Microalbuminuria is particularly relevant because it may appear before advanced renal disease becomes evident and can act as a marker of generalized endothelial and microvascular dysfunction. The association between renal and retinal abnormalities supports combined assessment of ocular

and systemic microvascular complications.⁵ Dyslipidaemia has also been investigated as a contributor to diabetic retinal disease. Abnormalities in total cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, and triglycerides may be associated with retinal lipid deposition and other manifestations of retinal damage. Lipid abnormalities are clinically important because they are frequent in type 2 diabetes and are potentially modifiable. Evaluation of the lipid profile can therefore complement assessment of glycaemic control and blood pressure while defining the overall risk profile for diabetic retinopathy and macular involvement.⁶ Additional clinical and metabolic characteristics may modify the likelihood and progression of diabetic retinopathy. These include age, sex, duration of diabetes, treatment modality, insulin requirement, glycaemic status, blood pressure, renal involvement, and associated systemic vascular abnormalities. The relative contribution of individual risk factors may vary across populations and according to the type and duration of diabetes. Clinical evaluation should therefore consider multiple variables simultaneously rather than relying on a single parameter. Multivariable assessment is particularly useful for identifying factors that remain independently associated with retinopathy after adjustment for other interrelated clinical and biochemical characteristics.⁷

MATERIALS & METHODS

Present study was conducted at Department of Ophthalmology, National Institute of Medical Sciences & Research, NIMS University, Jaipur, Rajasthan, India. A total of 105 patients with diabetes mellitus attending the Ophthalmology outpatient department and/or referred from the other departments were included. The study was designed to analyze the various demographic, systemic, metabolic, and ocular risk factors associated with the presence and severity of diabetic retinopathy. A total of 105 patients with a confirmed diagnosis of diabetes mellitus were enrolled. Patients were selected consecutively after fulfilling the predefined eligibility criteria. Both patients with and without clinical evidence of diabetic retinopathy were evaluated so that the relationship between potential risk factors and diabetic retinopathy could be assessed. Each participant underwent detailed systemic evaluation and comprehensive ophthalmological examination.

Inclusion Criteria: Patients aged 18 years or above with a confirmed diagnosis of type 1 or type 2 diabetes mellitus who attended the tertiary care hospital and consented to participate were included. Patients with diabetes irrespective of the duration of disease, treatment modality, glycaemic status, or presence or absence of diabetic retinopathy were eligible for inclusion.

Exclusion Criteria: Patients with significant media opacity preventing adequate visualization of the fundus,

including dense corneal opacity, advanced cataract, or vitreous haemorrhage obscuring retinal assessment, were excluded. Patients with retinal disorders unrelated to diabetes, previous retinal vascular occlusion, advanced glaucoma, or ocular trauma that could interfere with retinal evaluation were excluded. Patients with incomplete clinical or laboratory information and those unwilling to participate were also excluded.

Methodology: A detailed clinical history was recorded for every patient. Parameters included age, sex, type of diabetes mellitus, duration of diabetes, family history of diabetes, treatment received, and adherence to antidiabetic therapy. Information regarding smoking, alcohol consumption, sedentary lifestyle, dietary habits, and family history of diabetic retinopathy was obtained wherever applicable. A history of hypertension, dyslipidaemia, cardiovascular disease, cerebrovascular disease, diabetic nephropathy, and other diabetes-related complications was also documented.

Systemic Examination and Risk-Factor Assessment: Blood pressure was measured using a standard sphygmomanometer after adequate rest, and the presence of hypertension or ongoing antihypertensive treatment was recorded. Height and weight were measured, and body mass index was calculated as weight in kilograms divided by height in metres squared. Glycaemic control was assessed using fasting blood glucose, postprandial blood glucose, and glycated haemoglobin (HbA1c). Laboratory investigations also included serum total cholesterol, triglycerides, high-density lipoprotein cholesterol, low-density lipoprotein cholesterol, serum creatinine, and estimated renal function wherever available. Urine examination for albuminuria/proteinuria was performed to identify associated diabetic renal involvement.

Ophthalmological Examination: All patients underwent a detailed ophthalmic evaluation. Best-corrected visual acuity was assessed separately for each eye using a standard visual acuity chart. Anterior segment examination was performed using slit-lamp biomicroscopy, and intraocular pressure was measured by applanation tonometry or an available standard tonometric method. Pupils were dilated with an appropriate mydriatic agent, and fundus examination was carried out using direct and indirect ophthalmoscopy along with slit-lamp biomicroscopy using a non-contact fundus lens. Particular attention was given to the optic disc, retinal vessels, macula, microaneurysms, retinal haemorrhages, hard exudates, cotton-wool spots, venous abnormalities, intraretinal microvascular abnormalities, and retinal or disc neovascularization.

Assessment of Diabetic Retinopathy: Diabetic retinopathy was categorized according to internationally accepted clinical grading into no apparent diabetic retinopathy, mild non-proliferative diabetic retinopathy, moderate non-proliferative diabetic retinopathy, severe

non-proliferative diabetic retinopathy, and proliferative diabetic retinopathy. Diabetic macular oedema was assessed clinically by slit-lamp biomicroscopy, and optical coherence tomography was performed whenever clinically indicated to assess macular thickness and retinal morphology. In patients with bilateral involvement, the eye showing the more severe stage of diabetic retinopathy was considered for patient-wise severity analysis.

Evaluation of Risk Factors: The major risk factors evaluated for their association with diabetic retinopathy included age, sex, type of diabetes, duration of diabetes, poor glycaemic control, elevated HbA1c, hypertension, body mass index, dyslipidaemia, smoking, treatment modality, renal dysfunction, and albuminuria/proteinuria. These parameters were compared between patients with and without diabetic retinopathy. Risk factors were also analysed in relation to increasing severity of retinopathy wherever appropriate.

Statistical Analysis

The collected data were entered into a computerized database and analysed using appropriate statistical software. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequencies and percentages. The Chi-square test or Fisher's exact test was used to assess associations between categorical variables. The independent Student's t-test or Mann-Whitney U test was applied for comparison of continuous variables according to data distribution. Multivariable logistic regression analysis was performed to identify independent risk factors associated with diabetic retinopathy, and adjusted odds ratios with 95% confidence intervals were calculated. A p value of <0.05 was considered statistically significant.

RESULTS

A total of 105 patients with diabetes mellitus were included in the study. Regarding age distribution, 12 (11.43%) patients were aged ≤ 40 years, 25 (23.81%) were between 41 and 50 years, while 34 (32.38%) patients each belonged to the 51–60 years and >60 years age groups. Thus, the highest proportion of patients was observed in the 51–60 years and >60 years age categories. Of the total participants, 59 (56.19%) were males and 46 (43.81%) were females. According to the type of diabetes mellitus, 99 (94.29%) patients had type 2 diabetes mellitus, whereas only 6 (5.71%) had type 1 diabetes mellitus. On assessment of body mass index, 29 (27.62%) patients had normal BMI, 49 (46.67%) were overweight, and 27 (25.71%) were obese. With respect to antidiabetic treatment, 47 (44.76%) patients were receiving oral antidiabetic drugs, 33 (31.43%) were receiving insulin, while 25 (23.81%) were being treated with a combination of oral antidiabetic drugs and insulin. (Table 1)

Among the 105 patients, 47 (44.76%) had no apparent diabetic retinopathy, while 58 (55.24%) had some degree of diabetic retinopathy. Among patients with retinopathy, mild non-proliferative diabetic retinopathy was observed in 20 (19.05%) patients, moderate non-proliferative diabetic retinopathy in 16 (15.24%), and severe non-proliferative diabetic retinopathy in 12 (11.43%). Proliferative diabetic retinopathy was observed in 10 (9.52%) patients. Diabetic macular oedema was present in 18 (17.14%) of the total 105 patients, whereas 87 (82.86%) patients had no evidence of diabetic macular oedema. Therefore, the overall prevalence of diabetic retinopathy in the study population was 55.24%, while diabetic macular oedema was identified in 17.14% of participants. (Table 2)

Among the 58 patients with diabetic retinopathy, 25 (43.10%) were aged >60 years compared with 9 (19.15%) of the 47 patients without diabetic retinopathy. This difference was statistically significant ($p=0.009$). Male patients constituted 34 (58.62%) of the diabetic retinopathy group and 25 (53.19%) of the non-retinopathy group, with no statistically significant difference between the groups ($p=0.577$). A duration of diabetes exceeding 10 years was recorded in 37 (63.79%) patients with diabetic retinopathy compared with 12 (25.53%) patients without retinopathy, and the difference was statistically significant ($p<0.001$). HbA1c $\geq 7.0\%$ was present in 49 (84.48%) patients with retinopathy and 25 (53.19%) patients without retinopathy, showing a statistically significant association ($p<0.001$). Hypertension was present in 39 (67.24%) patients with diabetic retinopathy compared with 18 (38.30%) patients without retinopathy ($p=0.003$). Dyslipidaemia was observed in 35 (60.34%) patients with diabetic retinopathy and 17 (36.17%) patients without retinopathy, with a statistically significant difference ($p=0.014$). Smoking was reported in 19 (32.76%) patients with retinopathy compared with 9 (19.15%) without retinopathy; however, this difference was not statistically significant ($p=0.117$). Obesity was present in 20 (34.48%) patients with diabetic retinopathy and 7 (14.89%) patients without retinopathy, with a significant difference between the groups ($p=0.022$). Renal dysfunction was detected in 17 (29.31%) patients with diabetic retinopathy compared with 4 (8.51%) patients without retinopathy, and this difference was statistically significant ($p=0.008$). Albuminuria/proteinuria was present in 22 (37.93%) patients with retinopathy and 5 (10.64%) patients without retinopathy, showing a significant association ($p=0.001$). A family history of diabetes mellitus was reported in 26 (44.83%) patients with retinopathy and 17 (36.17%) patients without retinopathy; the difference was not statistically significant ($p=0.370$). (Table 3)

The mean age of patients with diabetic retinopathy was 59.80 ± 9.70 years compared with 53.60 ± 10.80 years

among those without diabetic retinopathy, and this difference was statistically significant ($p=0.003$). The mean duration of diabetes was significantly higher among patients with diabetic retinopathy, at 12.40 ± 5.80 years, compared with 7.10 ± 4.30 years among those without retinopathy ($p<0.001$). Mean BMI was 28.10 ± 3.90 kg/m² in the retinopathy group and 26.20 ± 3.60 kg/m² in the non-retinopathy group, with a statistically significant difference ($p=0.011$). The mean fasting blood glucose level was 167.40 ± 42.60 mg/dL among patients with diabetic retinopathy compared with 139.20 ± 35.10 mg/dL among those without retinopathy ($p<0.001$). Similarly, the mean postprandial blood glucose level was 245.60 ± 58.30 mg/dL in the retinopathy group and 198.40 ± 49.70 mg/dL in the non-retinopathy group, with the difference being statistically significant ($p<0.001$). Mean HbA1c was also significantly higher in patients with retinopathy, at $8.42 \pm 1.31\%$, compared with $7.21 \pm 1.18\%$ in patients without retinopathy ($p<0.001$). The mean total cholesterol level was 199.60 ± 35.80 mg/dL in patients with diabetic retinopathy and 184.20 ± 32.60 mg/dL in patients without retinopathy, with a significant difference ($p=0.023$). Mean triglyceride levels were 176.50 ± 48.90 mg/dL and 148.70 ± 42.50 mg/dL, respectively ($p=0.002$). The mean LDL-C level was 124.80 ± 31.40 mg/dL among patients with retinopathy compared with 110.20 ± 29.70 mg/dL among those without retinopathy ($p=0.016$). Mean HDL-C was lower in the retinopathy group at 40.80 ± 8.20 mg/dL compared with 44.10 ± 8.00 mg/dL in the non-retinopathy group, and the difference was statistically significant ($p=0.040$). Mean serum creatinine was 1.23 ± 0.47 mg/dL in patients with diabetic retinopathy compared with 0.96 ± 0.39 mg/dL in patients without retinopathy ($p=0.002$). (Table 4)

On multivariable logistic regression analysis, duration of diabetes >10 years was significantly associated with diabetic retinopathy, with an adjusted odds ratio (AOR) of 3.64 and a 95% confidence interval (CI) of 1.52–8.72 ($p=0.004$). HbA1c $\geq 7.0\%$ was also significantly associated with diabetic retinopathy, with an AOR of 3.28 (95% CI: 1.27–8.47; $p=0.014$). Hypertension demonstrated a statistically significant association, with an AOR of 2.46 (95% CI: 1.07–5.64; $p=0.034$). Albuminuria/proteinuria was also significantly associated with diabetic retinopathy, with an AOR of 2.87 (95% CI: 1.02–8.08; $p=0.046$). Age >60 years showed an AOR of 1.89 (95% CI: 0.75–4.74), but the association was not statistically significant after adjustment ($p=0.177$). Dyslipidaemia had an AOR of 1.72 (95% CI: 0.76–3.88; $p=0.192$), while obesity had an AOR of 1.65 (95% CI: 0.62–4.42; $p=0.319$). Smoking demonstrated an AOR of 1.41 (95% CI: 0.52–3.83; $p=0.500$), and renal dysfunction had an AOR of 2.12 (95% CI: 0.63–7.13; $p=0.225$). (Table 5)

Table 1. Demographic and Clinical Profile of Study Participants (n = 105)

Parameter	Category	Number (n)	Percentage (%)
Age group (years)	≤40	12	11.43
	41–50	25	23.81
	51–60	34	32.38
	>60	34	32.38
Sex	Male	59	56.19
	Female	46	43.81
Type of diabetes mellitus	Type 1	6	5.71
	Type 2	99	94.29
BMI category	Normal	29	27.62
	Overweight	49	46.67
	Obese	27	25.71
Treatment modality	Oral antidiabetic drugs	47	44.76
	Insulin	33	31.43
	Oral drugs + insulin	25	23.81

Table 2. Distribution according to severity of Diabetic Retinopathy and Diabetic Macular Oedema (n = 105)

Parameter	Category	Number (n)	Percentage (%)
Diabetic Retinopathy Status	No apparent diabetic retinopathy	47	44.76
	Mild non-proliferative diabetic retinopathy	20	19.05
	Moderate non-proliferative diabetic retinopathy	16	15.24
	Severe non-proliferative diabetic retinopathy	12	11.43
	Proliferative diabetic retinopathy	10	9.52
	Total	105	100.00
Diabetic Macular Oedema	Present	18	17.14
	Absent	87	82.86
	Total	105	100.00

Table 3. Association of Major Risk Factors with Diabetic Retinopathy

Risk Factor	Diabetic Retinopathy Present (n = 58), n (%)	Diabetic Retinopathy Absent (n = 47), n (%)	p value
Age >60 years	25 (43.10)	9 (19.15)	0.009
Male sex	34 (58.62)	25 (53.19)	0.577
Duration of diabetes >10 years	37 (63.79)	12 (25.53)	<0.001
HbA1c ≥7.0%	49 (84.48)	25 (53.19)	<0.001
Hypertension	39 (67.24)	18 (38.30)	0.003
Dyslipidaemia	35 (60.34)	17 (36.17)	0.014
Smoking	19 (32.76)	9 (19.15)	0.117
Obesity (BMI ≥30 kg/m ²)	20 (34.48)	7 (14.89)	0.022
Renal dysfunction	17 (29.31)	4 (8.51)	0.008
Albuminuria/proteinuria	22 (37.93)	5 (10.64)	0.001
Family history of diabetes mellitus	26 (44.83)	17 (36.17)	0.370

Table 4. Comparison of Clinical and Biochemical Parameters According to Diabetic Retinopathy Status

Parameter	Diabetic Retinopathy Present (n = 58), Mean $\pm$ SD	Diabetic Retinopathy Absent (n = 47), Mean $\pm$ SD	p value
Age (years)	59.80 $\pm$ 9.70	53.60 $\pm$ 10.80	0.003
Duration of diabetes (years)	12.40 $\pm$ 5.80	7.10 $\pm$ 4.30	<0.001
BMI (kg/m ²)	28.10 $\pm$ 3.90	26.20 $\pm$ 3.60	0.011
Fasting blood glucose (mg/dL)	167.40 $\pm$ 42.60	139.20 $\pm$ 35.10	<0.001
Postprandial blood glucose (mg/dL)	245.60 $\pm$ 58.30	198.40 $\pm$ 49.70	<0.001
HbA1c (%)	8.42 $\pm$ 1.31	7.21 $\pm$ 1.18	<0.001
Total cholesterol (mg/dL)	199.60 $\pm$ 35.80	184.20 $\pm$ 32.60	0.023
Triglycerides (mg/dL)	176.50 $\pm$ 48.90	148.70 $\pm$ 42.50	0.002
LDL-C (mg/dL)	124.80 $\pm$ 31.40	110.20 $\pm$ 29.70	0.016
HDL-C (mg/dL)	40.80 $\pm$ 8.20	44.10 $\pm$ 8.00	0.040
Serum creatinine (mg/dL)	1.23 $\pm$ 0.47	0.96 $\pm$ 0.39	0.002

Table 5. Multivariable Logistic Regression Analysis of Risk Factors Associated with Diabetic Retinopathy

Risk Factor	Adjusted Odds Ratio (AOR)	95% Confidence Interval	p value
Age >60 years	1.89	0.75–4.74	0.177
Duration of diabetes >10 years	3.64	1.52–8.72	0.004
HbA1c $\geq$ 7.0%	3.28	1.27–8.47	0.014
Hypertension	2.46	1.07–5.64	0.034
Dyslipidaemia	1.72	0.76–3.88	0.192
Obesity (BMI $\geq$ 30 kg/m ²)	1.65	0.62–4.42	0.319
Smoking	1.41	0.52–3.83	0.500
Renal dysfunction	2.12	0.63–7.13	0.225
Albuminuria/proteinuria	2.87	1.02–8.08	0.046

DISCUSSION

The present study included 105 patients with diabetes mellitus, with the largest proportions belonging to the 51–60 years and >60 years age groups (32.38% each), while only 11.43% were aged $\leq$ 40 years. Males constituted 56.19% and females 43.81% of the study population, and type 2 diabetes mellitus accounted for 94.29% of cases. Regarding nutritional status, 46.67% of patients were overweight and 25.71% were obese. Oral antidiabetic drugs alone were used by 44.76%, insulin alone by 31.43%, and a combination of oral drugs and insulin by 23.81%. Rema et al. (2000), in their study of 448 newly diagnosed South Indian patients with type 2 diabetes, reported a mean age of 48 $\pm$ 14 years and a male predominance of 69%. The mean BMI was 24.1 $\pm$ 3.5 kg/m² among males and 26.2 $\pm$ 5.0 kg/m² among females. Thus, the present study population was predominantly middle-aged or elderly and showed a substantial burden of increased BMI compared with the earlier South Indian diabetic cohort.⁸

Diabetic retinopathy was identified in 58 of the 105 patients (55.24%), whereas 47 (44.76%) had no apparent diabetic retinopathy. Mild NPDR was present in 19.05%, moderate NPDR in 15.24%, severe NPDR in 11.43%, and proliferative diabetic retinopathy in 9.52% of the total study population. Dandona et al. (1999), in a population-based study from Hyderabad, detected diabetic retinopathy in 28 of 124 persons with known diabetes, corresponding to approximately 22.6%. Among patients with retinopathy in their study, 50.0% had mild NPDR, 39.3% had moderate NPDR, and only 3.6% had proliferative retinopathy. The overall frequency of diabetic retinopathy and particularly proliferative disease was therefore higher in the present tertiary-care cohort than in their population-based sample.⁹

Diabetic macular oedema was present in 18 (17.14%) patients in the present study and was absent in 87 (82.86%). Raman et al. (2010), in the SN-DREAMS study involving 1,414 subjects with diabetes, reported diabetic macular oedema in 5.72% of the entire diabetic

population. Among the 255 subjects who had diabetic retinopathy, the prevalence of overall macular oedema was 31.76%, while non-clinically significant macular oedema and clinically significant macular oedema were observed in 25.49% and 6.27%, respectively. The overall prevalence of diabetic macular oedema of 17.14% in the present study was therefore higher than the 5.72% reported in the total diabetic population by Raman et al.¹⁰ Age, duration of diabetes, and glycaemic control showed important associations with diabetic retinopathy in the present study. Age >60 years was observed in 43.10% of patients with retinopathy compared with 19.15% without retinopathy ($p=0.009$). Duration of diabetes >10 years was present in 63.79% and 25.53%, respectively ($p<0.001$), while HbA1c $\geq 7.0\%$ was observed in 84.48% of patients with retinopathy compared with 53.19% without retinopathy ($p<0.001$). Male sex was slightly more frequent in the retinopathy group (58.62% versus 53.19%), but the difference was not significant ($p=0.577$). Rema et al. (2005), in the CURES Eye Study, reported an overall diabetic retinopathy prevalence of 17.6%, with a significantly higher prevalence among males than females (21.3% versus 14.6%; $p<0.0001$). They further demonstrated a 1.89-fold increase in the risk of retinopathy for every 5-year increase in diabetes duration and a 1.7-fold increase for every 2% rise in HbA1c. These observations were comparable with the significant relationships of longer diabetes duration and elevated HbA1c found in the present study, although sex was not significantly associated in the present cohort.¹¹

Glycaemic parameters were consistently higher among patients with diabetic retinopathy. Mean fasting blood glucose was 167.40 ± 42.60 mg/dL in the retinopathy group compared with 139.20 ± 35.10 mg/dL in patients without retinopathy ($p<0.001$), while corresponding postprandial glucose levels were 245.60 ± 58.30 mg/dL and 198.40 ± 49.70 mg/dL ($p<0.001$). Mean HbA1c was also significantly higher in patients with retinopathy ($8.42\pm 1.31\%$) than in those without it ($7.21\pm 1.18\%$; $p<0.001$). Pradeepa et al. (2008), analysing 1,715 gradable subjects from the CURES Eye Study, similarly found duration of diabetes and HbA1c to be independently associated with diabetic retinopathy severity. They reported that subjects in the highest quartile of postprandial glucose had a 7.7-fold risk of diabetic retinopathy compared with the lowest quartile, whereas the corresponding risk associated with fasting glucose was 4.2-fold. The findings closely paralleled the higher fasting glucose, postprandial glucose, and HbA1c values recorded among patients with retinopathy in the present study.¹²

Lipid abnormalities were also more frequent among patients with diabetic retinopathy in the present study. Dyslipidaemia was present in 60.34% of patients with retinopathy compared with 36.17% without retinopathy ($p=0.014$). Mean total cholesterol was 199.60 ± 35.80

versus 184.20 ± 32.60 mg/dL ($p=0.023$), triglycerides were 176.50 ± 48.90 versus 148.70 ± 42.50 mg/dL ($p=0.002$), and LDL-C was 124.80 ± 31.40 versus 110.20 ± 29.70 mg/dL ($p=0.016$). Conversely, HDL-C was lower in the retinopathy group (40.80 ± 8.20 versus 44.10 ± 8.00 mg/dL; $p=0.040$). Rema et al. (2006) also reported significantly higher serum cholesterol ($p=0.024$), triglyceride ($p=0.017$), and non-HDL cholesterol ($p=0.025$) levels among subjects with diabetic retinopathy. After adjustment for HbA1c and BMI, serum triglycerides remained significantly associated with retinopathy (standardized regression estimate 1.137; $p=0.007$), while LDL cholesterol remained associated with diabetic macular oedema (standardized regression estimate 1.358; $p=0.026$). These findings were consistent with the adverse lipid profile observed in the retinopathy group of the present study.¹³ Obesity was observed in 34.48% of patients with diabetic retinopathy compared with 14.89% of those without retinopathy ($p=0.022$), while mean BMI was 28.10 ± 3.90 kg/m² and 26.20 ± 3.60 kg/m², respectively ($p=0.011$). However, after multivariable adjustment, obesity did not remain independently significant (AOR 1.65, 95% CI 0.62–4.42; $p=0.319$). Similarly, smoking was present in 32.76% of patients with retinopathy and 19.15% without retinopathy but was not statistically significant ($p=0.117$), and its adjusted association also remained nonsignificant (AOR 1.41; $p=0.500$). Raman et al. (2010), in 1,414 diabetic subjects, demonstrated that the relationship between obesity and retinopathy depended on the measure of adiposity. Isolated abdominal obesity was associated with diabetic retinopathy (OR 2.02, 95% CI 1.06–3.86), whereas BMI ≥ 23 kg/m² was associated with an OR of 0.66 (95% CI 0.48–0.90). Their results, together with the loss of significance for obesity after adjustment in the present study, showed that general BMI and abdominal adiposity may exhibit different statistical relationships with diabetic retinopathy.¹⁴

Renal involvement showed a strong relationship with diabetic retinopathy in the present study. Renal dysfunction was present in 29.31% of patients with retinopathy compared with 8.51% without retinopathy ($p=0.008$), while albuminuria/proteinuria was recorded in 37.93% and 10.64%, respectively ($p=0.001$). Mean serum creatinine was also higher in the retinopathy group (1.23 ± 0.47 versus 0.96 ± 0.39 mg/dL; $p=0.002$). On multivariable analysis, duration of diabetes >10 years (AOR 3.64, 95% CI 1.52–8.72; $p=0.004$), HbA1c $\geq 7.0\%$ (AOR 3.28, 95% CI 1.27–8.47; $p=0.014$), hypertension (AOR 2.46, 95% CI 1.07–5.64; $p=0.034$), and albuminuria/proteinuria (AOR 2.87, 95% CI 1.02–8.08; $p=0.046$) remained independently associated with diabetic retinopathy. Raman et al. (2011) similarly reported that among patients with diabetes onset at ≤ 40 years, increasing diabetes duration carried an OR of 1.10

per year, worsening glycaemic control an OR of 1.36 per 1% increase in HbA1c, and macroalbuminuria an OR of 13.39 for diabetic retinopathy. Among those with later-onset diabetes, microalbuminuria was associated with an OR of 2.08 and increasing systolic blood pressure with an OR of 1.01. These observations were comparable with the independent associations of prolonged diabetes, poor glycaemic control, hypertension, and albuminuria demonstrated in the present analysis.¹⁵

CONCLUSION

Diabetic retinopathy was common among the studied diabetic patients and was significantly associated with longer duration of diabetes, poor glycaemic control, hypertension, dyslipidaemia, obesity, renal dysfunction, and albuminuria/proteinuria. On multivariable analysis, duration of diabetes >10 years, HbA1c $\geq 7.0\%$, hypertension, and albuminuria/proteinuria emerged as significant independent risk factors. Patients with diabetic retinopathy also showed higher blood glucose, lipid, and serum creatinine levels. Regular ophthalmic screening along with strict control of systemic and metabolic risk factors is essential for early detection and prevention of progression of diabetic retinopathy.

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How to cite the article: Nishit Dhoka. Analysis of Risk Factors of Diabetic Retinopathy: An Institutional Based Study. *Int J Med Res Prof*. 2015, 1(2); 239-46.