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Original Research Article

Prevalence and Severity of Diabetic Retinopathy and Its Association with HbA1c Levels Among Type 2 Diabetes Mellitus Patients in in Sri Krishna Medical college, Muzaffarpur

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Abstract:

Background: Diabetic retinopathy (DR) is a leading microvascular complication of Type 2 Diabetes Mellitus (T2DM) and a major preventable cause of blindness. Chronic hyperglycaemia, reflected by glycated haemoglobin (HbA1c), plays a crucial role in retinal damage, yet regional data from eastern India remain limited.

Aim: To determine the prevalence and severity of diabetic retinopathy and evaluate its association with HbA1c levels among T2DM patients attending a Skmch in Muzaffarpur, Bihar.

Methodology: A hospital-based cross-sectional study was conducted on 60 T2DM patients (≥30 years) . Detailed ophthalmic examination with dilated fundus evaluation classified DR into NPDR and PDR stages. HbA1c was measured and categorized as good (<7%), fair (7–8%), and poor (>8%). Association was assessed using Chi-square test.

Results: DR prevalence was 70% (42/60). NPDR accounted for 46.66% and PDR for 23.33%. Poor glycaemic control was present in 51.67% patients. Higher HbA1c was significantly associated with increasing severity of DR (χ^2=18.62, p=0.0009). Longer duration of diabetes also showed significant association (p=0.002).

Conclusion: Diabetic retinopathy is highly prevalent, and increasing HbA1c levels strongly correlate with both occurrence and severity of retinopathy. Strict glycaemic control and regular screening are essential to prevent vision-threatening complications.

Keywords: Type 2 Diabetes Mellitus, Diabetic Retinopathy, HbA1c, Glycaemic Control, Prevalence, Severity.

Introduction

Diabetes mellitus (DM) is a long-term metabolic disease that is typified by sustained hyperglycemia caused by insulin secretion defects, insulin action defects, or a combination of both. With time, long-term elevation of blood glucose has structural and functional impairment of multiple organs, especially eyes, kidneys, nerves, heart, and blood vessels. Diabetic retinopathy (DR) is one of these complications among others, and it ranks as one of the highest causes of preventable blindness in the world. One of the common complications of DM is diabetic retinopathy which causes blindness. It happens as a result of eventual damage to the retinal microvasculature leading to vascular leaks, capillary blockage, retinal ischemia, and neovascularization. One of the primary causes of the loss of the vision of adults remains to be diabetic retinopathy that occurs when the blood vessels in the eyes are damaged [1].

DR imposes visual impairment to people who are mostly in their most productive years of life. Blindness in people in the age category of 2065 years is normally due to diabetic retinopathy [2]. Due to the fact that this age group is the working population, the burden of the socioeconomic aspect of DR is especially great as it affects the individual and the healthcare system. Notably, the danger of DR is not confined to the specific form of diabetes. About 45 percent of people with Type 1 Diabetes Mellitus (T1DM) and Type 2 Diabetes Mellitus (T2DM) have diabetic retinopathy [3]. Nonetheless, T2DM is the major cause of diabetes in most parts of the world, thus it is overrepresented as a contributor to the burden of diabetic eye disease.

Diabetes mellitus is a global problem that is gaining high prevalence levels and turns into an epidemic. In the world, the prevalence of diabetes mellitus is at

9.3 per cent and it has been found that there are 463 million diabetic patients, and these are expected to increase to 578 million (10.2) by 2030. The rate of diabetes in India is approximately 8.9% [4] . India has been dubbed the diabetes capital with the high number of the affected people and the increasing cases of the disease in both rural and urban populations. This rise of prevalence leads to a similar rise in diabetic complications such as diabetic retinopathy which has become a significant issue of public health concern.

The problems of diabetes mellitus are widely divided into macrovascular and microvascular problems. Cardiovascular diseases like coronary artery disease and stroke are macrovascular issues that are prevalent at a rate of about 50. Microvascular problems involve smaller blood vessels and include diabetic nephropathy, neuropathy, and retinopathy, and it occurs in approximately 27% of T2DM patients [5]. Diabetic retinopathy is one of them that is especially significant since it poses a direct threat to the quality of life and vision.

Diabetic Retinopathy (DR) is a significant microvascular complication in diabetes and is also clinically divided into two stages, namely Non-Proliferative Diabetic Retinopathy (NPDR) and Proliferative Diabetic Retinopathy (PDR). NPDR is the mild case, and it is noted by the appearance of microaneurysms, intraretinal hemorrhages, hard exudates, and cotton wool spots. PDR is the severe form and is associated with the retinal neovascularization, the vitreous hemorrhage, and the tractional retinal detachment, resulting in the extreme loss of vision [6]. The NPDR stage is crucial in early detection as the disease can be prevented at an irreversible stage of blindness, which is caused by timely management.

Diabetic Macular Edema (DME) has also been identified as another vision threatening complication of DR that presents itself in the form of swelling and thickening of the macula owing to fluid build-up. It is the commonest cause of blindness in patients with diabetic retinopathy [7]. Even none of the patients with advanced proliferative changes may lose his/her sight seriously in case of the development of macular edema. In a cohort design study, it was found that the retrospective cohort study showed that the eyes with moderate NPDR, severe NPDR, and PDR had higher chances of attaining sustained blindness after two years of diagnosis than the eyes with milder disease [8]. These results make it clear that it is important to define the severity of the disease and start with the early treatment.

Glycated haemoglobin (HbA1c) is one of the biochemical signs used in the management of diabetes. HbA1c is an indicator of the chronic level of blood glucose and a measure of the levels of average blood glucose in the past 12-13 months [9]. Its extensive application in the diagnosis and management of diabetes is due to the fact it gives a long-term measure of glycaemic control. HbA1c testing is regarded as one of the most effective measurements of evaluation as the results of the test are strongly correlated with diabetic complications.

A number of research have indicated a high relationship between the level of HbA1c and the development of diabetic retinopathy. In one study, odds ratio of diabetic retinopathy was found to be significantly greater when HbA1c obtained was 6.8 and above. In another study, the cut-off value of 6.6% was found to be optimum in the detection of the existence of any diabetic retinopathy [10]. These results show that retinal damage is highly associated with poor glycaemic control. Nevertheless, there are several factors that may affect the level of HbA1c. Sumner et al. implied that HbA1c levels might be influenced by different risk factors such as anemia, hemoglobinopathies and physiological differences. Thus, although HbA1c is still a useful measure, clinical context needs to be taken into account.

Severity of diabetic retinopathy relies on several factors which are clinical and systemic. Such important determinants are years of diabetes mellitus, glycaemic control, hypertension, nephropathy, smoking, and cataract surgery [11] history. The presence of hyperglycaemia over a longer period and continuous presence of diabetes contribute immensely to the retinal microvascular damage. Besides, retinopathy progression is closely related to renal involvement. Microalbuminuria has also been found out as another important factor that is closely related to the development of diabetic retinopathy [12]. High-grade microalbuminuria is deemed as the primary factor leading to progressive diabetic retinopathy, which implies that the pathogenic mechanisms of retinal and renal microvascular damage are common.

Among developing countries like India, it is known that there is a greater burden of advanced diabetic retinopathy in lack of awareness, delayed diagnosis, inadequate glycaemic control and inadequate access to specialized eye care. Most patients turn up when they are already impaired by visual impairment thus at this point there are very few treatment options available. Early diagnosis and screening, especially in tertiary care facilities, is crucial in the identification of retinopathy before vision loss sets in. The determination of the correlation between the severity of diabetic retinopathy and HbA1c levels will contribute to the identification of the patients at a high risk and appropriate prevention measures.

Although the problem of diabetes is high in India, there is a lack of region-specific data of the correlation between HbA1c and the extent of diabetic retinopathy, particularly, in eastern regions of the country. Muzaffarpur, Bihar, serves a large population from surrounding rural and semi-urban areas where

access to regular screening is often inadequate. Understanding the local prevalence and severity pattern of DR in relation to glycaemic control is essential for planning screening programs, patient education, and targeted interventions.

Therefore, the objective of the present study was to assess the prevalence and severity of diabetic retinopathy and its association with HbA1c levels among patients with Type 2 Diabetes Mellitus attending a tertiary care center in Muzaffarpur, Bihar, India. By correlating biochemical parameters with clinical staging of retinopathy, the study aims to contribute to early detection strategies and improve preventive ophthalmic care among diabetic patients.

Methodology

Study Design: The present research was conducted as a hospital-based cross-sectional observational study to determine the prevalence and severity of diabetic retinopathy and to evaluate its association with HbA1c levels among patients diagnosed with Type 2 Diabetes Mellitus. The study assessed ocular findings and glycaemic control status at a single point in time without any intervention.

Study Area: The study was carried out in the Department of Ophthalmology, Sri Krishna Medical College and Hospital, Muzaffarpur, Bihar, India

Study Duration: The study was conducted over a period of six months, from March 2025 to August 2025

Sample Size: A total of 60 patients fulfilling the eligibility criteria were included in the study. All patients presenting during the study period and meeting inclusion criteria were enrolled until the required sample size was achieved.

Study Population: The study population consisted of diagnosed cases of Type 2 Diabetes Mellitus attending the ophthalmology outpatient department for routine eye examination or referred for diabetic eye screening. Both male and female patients above 30 years of age were included irrespective of duration of diabetes and treatment status.

Data Collection: Data collection was carried out using a pre-designed structured proforma. A detailed medical and ocular history was obtained including duration of diabetes, treatment history, systemic complications, and previous ocular diseases. All patients underwent comprehensive ophthalmic examination including measurement of best corrected visual acuity using Snellen chart for distant vision and Jaeger chart for near vision. Intraocular pressure was measured using Goldmann applanation tonometer and anterior segment evaluation was performed using slit lamp biomicroscopy. Pupillary dilatation was done using topical 2.5% phenylephrine and 0.5% tropicamide instilled at 10–15-minute intervals with punctal occlusion. Dilated fundus examination was performed using indirect ophthalmoscope with 20D lens to detect and grade diabetic retinopathy. A 3 ml venous blood sample was collected from each patient and sent to the pathology laboratory for HbA1c estimation.

Inclusion Criteria

- Diagnosed cases of Type 2 Diabetes Mellitus
- Age ≥ 30 years
- Patients willing to participate and provide informed consent
- Patients who underwent HbA1c testing during the study period

Exclusion Criteria

- Type 1 Diabetes Mellitus
- Gestational diabetes
- Media opacity preventing fundus examination (dense cataract, corneal opacity)
- Pre-existing non-diabetic retinopathy or maculopathy
- Non-diabetic renal disorders
- Previous retinal laser photocoagulation therapy
- Ocular trauma or surgery (except uncomplicated cataract surgery)
- Known neurological disorders affecting retina

Procedure: Eligible patients were identified in the outpatient department and informed consent was obtained. Detailed history was recorded followed by complete ophthalmic examination. Pupillary dilatation and fundus examination were performed to identify and grade diabetic retinopathy into no retinopathy, mild non-proliferative diabetic retinopathy (NPDR), moderate NPDR, severe NPDR, and proliferative diabetic retinopathy (PDR). Blood samples were collected for HbA1c estimation and patients were categorized into good, fair, and poor glycaemic control groups based on HbA1c levels. The ocular findings were then correlated with glycaemic control status.

Statistical Analysis: The collected data were entered into Microsoft Excel and analyzed using the latest version of SPSS software. Descriptive statistics such as mean, standard deviation, frequencies, and percentages were calculated. The association between severity of diabetic retinopathy and HbA1c levels was assessed using the Chi-square test. A p-value less than or equal to 0.05 was considered statistically significant."

Result

Table 1 shows the age and gender distribution of the 60 study subjects. There were 38 males and 22 females overall. The largest age group was 51–60 years (18 patients, 30.00%), followed by 41–50 years (16 patients, 26.67%) and 61–70 years (12 patients, 20.00%). The 30–40 years group included 8 patients (13.33%), while >70 years had 6 patients

(10.00%). Across all age groups, males outnumbered females, indicating a male predominance in the study population.

Table 1: Age and Gender distribution of study subjects (N = 60)				
Age group (Years)	**Male**	**Female**	**Total**	**Percentage**
30 – 40	5	3	8	13.33%
41 – 50	10	6	16	26.67%
51 – 60	12	6	18	30.00%
61 – 70	7	5	12	20.00%
>70	4	2	6	10.00%
Total	**38**	**22**	**60**	**100%**

Table 2 shows the duration of Type 2 diabetes mellitus among 60 patients. The largest group had diabetes for 5–10 years (24 cases, 40.00%), followed by 10–20 years (18 cases, 30.00%). 12 patients (20.00%) had duration <5 years, while 6 patients (10.00%) had diabetes for >20 years. Overall, most participants had a disease duration between 5 and 20 years.

Table 2: Duration of Type 2 Diabetes Mellitus		
Duration (years)	**No. of cases**	**Percentage**
<5 years	12	20.00%
5 – 10 years	24	40.00%
10 – 20 years	18	30.00%
>20 years	6	10.00%
Total	**60**	**100%**

Table 3 presents the HbA1c levels of the 60 study participants. Good glycaemic control (<7%) was seen in 15 patients (25.00%), fair control (7–8%) in 14 patients (23.33%), and poor control (>8%) in 31 patients (51.67%). Overall, more than half of the participants had poor glycaemic control.

Table 3: HbA1c level of study participants			
HbA1c Level	**Glycaemic Control**	**No. of cases**	**Percentage**
<7%	Good control	15	25.00%
7 – 8%	Fair control	14	23.33%
>8%	Poor control	31	51.67%
Total		**60**	**100%**

Table 4 shows the prevalence of diabetic retinopathy among 60 patients. Diabetic retinopathy (DR) was present in 42 patients (70.00%), while 18 patients (30.00%) had no DR. Overall, the findings indicate a high prevalence of retinopathy in the study population.

Table 4: Prevalence of Diabetic Retinopathy		
Retinopathy Status	**No. of cases**	**Percentage**
No DR	18	30.00%
DR Present	42	70.00%
Total	**60**	**100%**

Table 5 presents the severity distribution of diabetic retinopathy among 60 patients. No DR was observed in 18 cases (30.00%). Among non-proliferative diabetic retinopathy (NPDR), mild NPDR occurred in 6 cases (10.00%), moderate NPDR in 14 cases (23.33%), and severe NPDR in 8 cases (13.33%). For proliferative diabetic retinopathy (PDR), moderate PDR was seen in 6 cases (10.00%) and severe PDR in 8 cases (13.33%). Overall, NPDR constituted the majority of DR cases, with a considerable proportion progressing to proliferative stages.

Table 5: Severity of Diabetic Retinopathy		
Severity of DR	**No. of cases**	**Percentage**
No DR	18	30.00%
Mild NPDR	6	10.00%
Moderate NPDR	14	23.33%
Severe NPDR	8	13.33%
Moderate PDR	6	10.00%
Severe PDR	8	13.33%
Total	**60**	**100%**

Table 6 demonstrates the relationship between HbA1c level and severity of diabetic retinopathy among 60 patients. With HbA1c <7%, 10 patients had no DR, 5 had NPDR, and none had PDR (total 15). In the 7–8% group, 6 had no DR, 6 had NPDR, and 2 had PDR (total 14). When HbA1c >8%, only 2 had no DR, while 17 had NPDR and 12 had PDR (total 31). Overall, out of 60 patients, 18 had no DR, 28 had NPDR, and 14 had PDR, indicating that higher HbA1c levels are associated with increased presence and severity of diabetic retinopathy.

Table 6: Association between HbA1c level and Diabetic Retinopathy severity				
HbA1c Level	**No DR**	**NPDR**	**PDR**	**Total**
<7%	10	5	0	15
7 – 8%	6	6	2	14
>8%	2	17	12	31
Total	**18**	**28**	**14**	**60**

Chi-square = 18.62
p-value = 0.0009 (Statistically Significant)

Table 7 shows the association between duration of diabetes mellitus and diabetic retinopathy (DR) among 60 patients. In patients with diabetes for <5 years, 9 had no DR while 3 had DR (total 12). With 5–10 years duration, 6 had no DR and 18 had DR (total 24). In the 10–20 years group, only 2 had no DR whereas 16 had DR (total 18). Among those with >20 years duration, 1 had no DR and 5 had DR (total 6). Overall, 42 patients had DR and 18 had no DR, showing a clear increase in prevalence of diabetic retinopathy with longer duration of diabetes.

Table 7: Association of duration of diabetes with DR			
Duration of DM	**No DR**	**DR Present**	**Total**
<5 years	9	3	12
5 – 10 years	6	18	24
10 – 20 years	2	16	18
>20 years	1	5	6
Total	**18**	**42**	**60**

Chi-square = 14.21
p-value = 0.002 (Significant)

Discussion

In the current study that was carried out in a tertiary care center in Muzaffarpur, Bihar, DR was identified in 70% of patients, and this suggests a high burden. As in similar studies of hospitals, high prevalence has also been reported in literature under similar studies; Singh et al. found high percentage of diabetic patients being subject to a retinopathy in ophthalmic services [13] and Garg and Ahmad found significant prevalence of various stages of DR in Indian populations [14]. Nonetheless, community-based studies have tended to have demonstrably lower prevalence, and there is an indication that tertiary-care centers tend to get more advanced or complicated cases. Therefore, the increased prevalence of our results can be a manifestation of referral bias and late presentation, which is typical of resources-limited environments."

The age demographics of our research have the highest number of patients in 51-60 years age group (30%), 41-50 years age (26.67) which is consistent with the epidemiological characteristics of type 2 diabetes as a disease of middle-aged and old age. The same was observed by Eqbal et al. where most of the cases were found to be in 51-60 years [15] and Kumar et al. found that they clustered around 50-60 years [16]. Similar results were presented by Singh et al. who discovered that the majority of patients with DR were over 50 years old [13]. These correspondences reinforce the fact that aging is another causative factor in developing microvascular damage in the retina because of accumulated metabolic

stress. Contrastingly, the mean age of Manaviat et al. was a little younger yet within the middle-age range [17] which shows that in spite of the fact that age groups might differ among populations, the DR usually develops after the many years of hyperglycemia.

Our study was male dominant (63.3). Similar male supremacy has been reported by Singh et al. [13], Kumar et al. [16], and Santos et al. [23]. Male prevalence was also increased in an Indian study [14]. Nevertheless, it was found that female predominance was reported by Manaviat et al. [17], so it may be that gender disparities are not necessarily based on biological vulnerability, but instead on healthcare-seeking behavior. Access to tertiary care is higher among men in most developing areas and this could be the reason behind the trend instead of there being an epidemiological difference.

Diabetes duration exhibited a significant relationship with DR in our study with the maximum prevalence observed in patients with 1020 years of duration and above ($p = 0.002$). Retinopathy was mostly not observed in patients with a duration of less than 5 years. This observation is similar to the results of the UKPDS trial that risk is increased with the duration of the disease. Equally, Savage et al. found that the severity of complication increased with increased duration of diabetes [19] and Garg et al. found that period is a significant factor of severity [20]. These similar findings in all the studies confirm that chronic hyperglycemia causes gradual destruction of the retinal capillaries and this warrants timely diagnosis and follow up.

In our study, Glycaemic control correlated significantly with severity of DR ($p = 0.0009$). Over half of the study population (51.67) were poorly glycaemically controlled (HbA1c >8%), and these patients are the ones that exhibited greater NPDR and PDR. Patel et al. also observed that the mean HbA1c progressively increased based on the retinopathy grades [21]. On the same note, Badawi et al. established HbA1c as an independent risk factor [22] and Ahmed et al. had high correlation between poor control and retinopathy severity [23] as well. All these findings demonstrate that HbA1c is a prognostic tool of retinal damage. Conversely, patients who had a HbA1c below 7% in our research had largely no retinopathy, which backs the idea of tight glycaemic control in the prevention of microvascular complications, as shown in large trials.

In terms of severity, moderate NPDR was predominant in our study (23.33%), whereas severe NPDR and severe PDR were ranked as the second and the third (13.33% each). Niveditha et al. found also the prevalence of NPDR over PDR [24] as we did. Nonetheless, there are studies based in hospitals, which have shown that there is greater proliferative disease because of late presentation showing that it is variable based on the screening practices. We have found that late presentation by many patients may still be screened and have disease detected before proliferative complications in a significant fraction.

The correlation between the severity of DR and HbA1c indicated in this research is added evidence of research that has been carried out in the past. Patients who had low HbA1c of less than 7% did not have any proliferative disease but those with high HbA1c of over 8% had advanced stages. Both Valizadeh et al. and Ahmed et al. showed the progressive severity increase with the increase of HbA1c [25] and the strong correlation between glycaemic levels and DR stage [23], respectively. This shows that HbA1c is not only a diagnostic tool, but also a prognostic tool in assessing the development of retinal damage.

The combination of longer periods and inadequate glycaemic control further increased severity in our population with previous results that chronic exposure to hyperglycemia leads to cumulative endothelial damage. Chung et al. also recorded such interaction [26] between duration and microvascular complications. Therefore, there is a synergistic relationship, not independence between the two parameters in the prediction of disease progression.

Generally, our results are consistent with several national and international studies that have established that age of onset, duration of diabetes, and high HbA1c levels are considerable factors that contribute to prevalence and severity of diabetic retinopathy. His or her small differences in gender representation and percentage of stages in research can be explained by the differences in demography and access to healthcare. The prevalence rate is high in our tertiary care unit and this highlights the role of regular screening and strong measures of glycaemic control in eliminating avoidable blindness in diabetic individuals.

Conclusion

The current research undertaken in a tertiary care unit in Muzaffarpur, Bihar illustrates that diabetic retinopathy is widespread in patients with type 2 diabetes mellitus, with non-proliferative form being predominant and proliferative stages found in a significant proportion of patients. The results show that a decrease in glycaemic control measured by increment of HbA1c groups has a close correlation with the development and progressive elevation of retinopathy. Furthermore, the longer the time of diabetes, the stronger the correlation with the retinal changes, implying the progressive metabolic damage with time. All in all, the paper identifies inadequate metabolic control and long disease course as determinants of the severity of retinopathy, which leads to the conclusion of the need to provide rigorous glycaemic control and timely ophthalmic

screening to prevent retinopathy-related vision loss and avoidance of eye-threatening complications.

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