Original Research

STUDY OF OCULAR MANIFESTATIONS AND THEIR ASSOCIATION WITH GLYCEMIC CONTROL IN TYPE 2 DIABETES MELLITUS IN A TERTIARY CARE HOSPITAL

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ABSTRACT
Background: Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder associated with long-term microvascular and macrovascular complications. Ocular manifestations are among the most common complications and are a major cause of preventable visual impairment. The present study aimed to assess the association between ocular manifestations and glycemic control in patients with T2DM.
Methodology: A hospital-based cross-sectional observational study was conducted in the Department of General Medicine at Sree Mookambika Institute of Medical Sciences from December 2024 to March 2025. A total of patients diagnosed with T2DM were included. Detailed history, ocular complaints, and comprehensive ophthalmological examination were performed. Glycemic control was assessed using fasting blood sugar (FBS), postprandial blood sugar (PPBS), and glycated hemoglobin (HbA1c). Data were analyzed using SPSS software, and appropriate statistical tests including chi-square and Student's t-test were applied.
Results: Cataract was the most common ocular manifestation, followed by diabetic retinopathy, dry eye disease, and lid disorders. A significant association was observed between poor glycemic control and increased severity of ocular complications. Longer duration of diabetes was also associated with higher prevalence of diabetic retinopathy.
Conclusion: Poor glycemic control is strongly associated with increased ocular complications in T2DM. Regular ophthalmic screening and strict glycemic control are essential to prevent vision-threatening complications.

Keywords: Type 2 Diabetes Mellitus, Ocular Manifestations, Glycemic Control, Diabetic Retinopathy, Cataract, and Visual Impairment.

INTRODUCTION
Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from defects in insulin secretion, insulin action, or both.[1] It is broadly classified into type 1 diabetes mellitus and type 2 diabetes mellitus (T2DM). Type 1 diabetes mellitus results from absolute or near-total insulin deficiency due to autoimmune destruction of pancreatic β-cells, whereas T2DM is primarily caused by insulin resistance combined with progressive β-cell dysfunction.[2] During the initial stages of insulin resistance, pancreatic β-cells compensate by producing increased amounts of Insulin to maintain normal glucose levels. However, prolonged β-cell overactivity eventually leads to β-cell exhaustion and development of overt T2DM.[3]

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Chronic hyperglycemia associated with diabetes mellitus causes long-term damage, dysfunction, and failure of various organs, particularly the eyes, kidneys, nerves, heart, and blood vessels.[4] Among these complications, ocular manifestations are one of the most important causes of morbidity because they can lead to visual impairment and blindness if not diagnosed and treated early.[5] Diabetic eye disease encompasses a wide range of ocular disorders including diabetic retinopathy, cataract, glaucoma, refractive errors, cranial nerve palsies, dry eye syndrome, and retinal vascular occlusions.[6] The severity and progression of these ocular complications are closely associated with the duration of diabetes, poor glycemic control, hypertension, dyslipidemia, and other systemic risk factors.[7]
India is often referred to as the "diabetes capital of the world" because of the rapidly increasing burden of diabetes mellitus.[8] According to global estimates, approximately 41 million Indians were affected by diabetes in the early 2000s, and the prevalence continues to rise significantly due to urbanization, sedentary lifestyle, unhealthy dietary habits, obesity, and genetic predisposition.[9] The World Health Organization and International

Diabetes Federation (IDF) have projected a substantial increase in the global diabetic population over the coming decades.[10] It has been estimated that the number of people with diabetes worldwide may rise from 171 million in 2000 to nearly 366 million by 2030 and continue increasing thereafter.[11] The IDF Diabetes Atlas reported that the prevalence of diabetes increased from 8.8% in 2017 and is expected to reach approximately 11.4% by 2045.[12]

Diabetic eye disease has emerged as a major public health concern due to its increasing prevalence and impact on quality of life.[13] Persistent hyperglycemia causes microvascular damage, oxidative stress, inflammation, and endothelial dysfunction leading to retinal ischemia and vascular leakage.[14] Diabetic retinopathy remains the most common ocular complication and is one of the leading causes of preventable blindness among working-age adults worldwide.[15] Poor glycemic control, reflected by elevated glycated hemoglobin (HbA1c) levels, has been strongly associated with progression of diabetic retinopathy and other ocular complications.[16] Early identification and strict glycemic control can significantly reduce the risk of visual impairment and delay disease progression.[17]

Regular ophthalmological screening and timely intervention are essential for preventing vision-threatening complications in diabetic patients.[18] Understanding the relationship between glycemic control and ocular manifestations may help clinicians identify high-risk individuals and improve patient outcomes through early management strategies. Therefore, the present study was undertaken to evaluate the association between ocular manifestations and glycemic control among patients with type 2 diabetes mellitus.

Aim

To evaluate the association between ocular manifestations and glycemic control among patients with Type 2 diabetes mellitus.

Objectives

1. To study the demographic profile of patients with Type 2 diabetes mellitus presenting with ocular manifestations.
2. To identify the various ocular manifestations associated with Type 2 diabetes mellitus.
3. To assess glycemic control among study participants using fasting blood sugar, postprandial blood sugar, and glycated hemoglobin (HbA1c) levels.

METHODOLOGY

This hospital-based cross-sectional observational study was conducted in the Department of General Medicine at Sree Mookambika Institute of Medical Sciences during the study period from December 2024 to March 2025. The study was undertaken to evaluate the association between ocular manifestations and glycemic control among patients with Type 2 diabetes mellitus. Patients diagnosed with Type 2 diabetes mellitus attending the outpatient and inpatient departments were included in the study after obtaining informed consent.

A detailed clinical history was obtained from each participant, including duration of diabetes, treatment history, associated co-morbidities, and ocular complaints such as blurred vision, diminished vision, eye pain, redness, watering, diplopia, and floaters. Comprehensive general physical examination and systemic examination were carried out for all patients. Complete ophthalmological evaluation was performed, including assessment of visual acuity, anterior segment examination, fundoscopy, and evaluation for diabetic retinopathy and other ocular manifestations associated with diabetes mellitus.

Relevant laboratory investigations including fasting blood sugar (FBS), postprandial blood sugar (PPBS), and glycated hemoglobin (HbA1c) were performed to assess glycemic control. The association between glycemic status and ocular manifestations was analyzed. Data obtained from the study participants were compiled and entered into Microsoft Excel spreadsheet for tabulation and analysis.

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) software version 21 operating on Windows 10. Descriptive statistics were summarized using mean, median, frequency, percentage, and proportion wherever appropriate. Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were represented as frequencies and percentages using tables and figures. Student's t-test was used to compare the mean differences between continuous variables, and Chi-square test was applied for categorical variables to determine statistical association. A p-value of less than 0.05 was considered statistically significant.

Total of 150 patients, in age group of 51-60yrs (47.3%) followed by 61-70yrs (25.34%). Among the gender 69 were male and 81 were female patients with marginal female preponderance in the study.

Table 1: Various Ocular Manifestation among Study Participants

Ocular Morbidity	No. Of Cases	Percentage (%)
Lids And Adnexa	17	11.33
Conjunctiva	19	12.66
Cornea	33	22

Dacrocystitis	02	1.33
Glaucoma	05	3.33
Lens	100	66.66
Vitreous	09	6
Optic Disc	03	2
Retina	56	37.33
Cranial Nerves	02	1.33

Table 2: Showing the Ocular Manifestations among Study Participants

		No. Of Patients	Percentage (%)
Type Of Lid Lesion	Stye	02	11.77
	Blepharitis	11	64.71
	Xanthelasma	01	5.88
	Wart	01	5.88
	Recurrent Chalazion	01	5.88
	Preseptal Cellulitis	01	5.88
Type Of Conjunctival Involvement	Conjunctivitis	02	10.52
	Tortous Conjunctival Vessels	5	26.32
	Pterygium	10	52.64
	Pinguecula	2	10.52
Type Of Dacryocystitis	Acute	01	50
	Chronic	01	50
Corneal Lesions	Reduced Corneal Sensation	03	9.09
	Non Healing Corneal Ulcers	00	00
	Dry Eye Disease	30	90.91
Type Of Glaucoma	Paog	03	60
	Pacg	01	20
	NVG	01	20
Type Of Response	Full Dilatation	135	90
	Poor Dilatation	15	10
Type Of Cataract	Cortical	22	22
	Nuclear	14	14
	Posterior Sub Capsular	06	06
	Mixed	58	58
Vitreous Finding	Asteroid Hyalosis	01	11.11
	Synchysis Scintillans	01	11.11
	Microfibrillary Degeneration	05	55.56
	Firovascular Proliferation With Vitreous Hemorrhage	01	11.11
	Fibro Vascular Proliferation Without Vitreous Hemorrhage	01	11.11
Type Of Retinopathy	Mild NPDR	20	39.21
	Moderate NPDR	13	25.49
	Severe NPDR	03	5.88
	PDR	13	5.49
	PDR With Tractional RD	02	3.93
Other Retinal Lesions	ARMD	03	60
	CRAO	01	20
	BRVO	01	20
	ARMD	03	60
Optic Nerve Lesions	NA-AION	01	33.33
	Optic Neuritis	01	33.33
	Optic Atrophy	01	33.33
	NA-AION	01	33.33

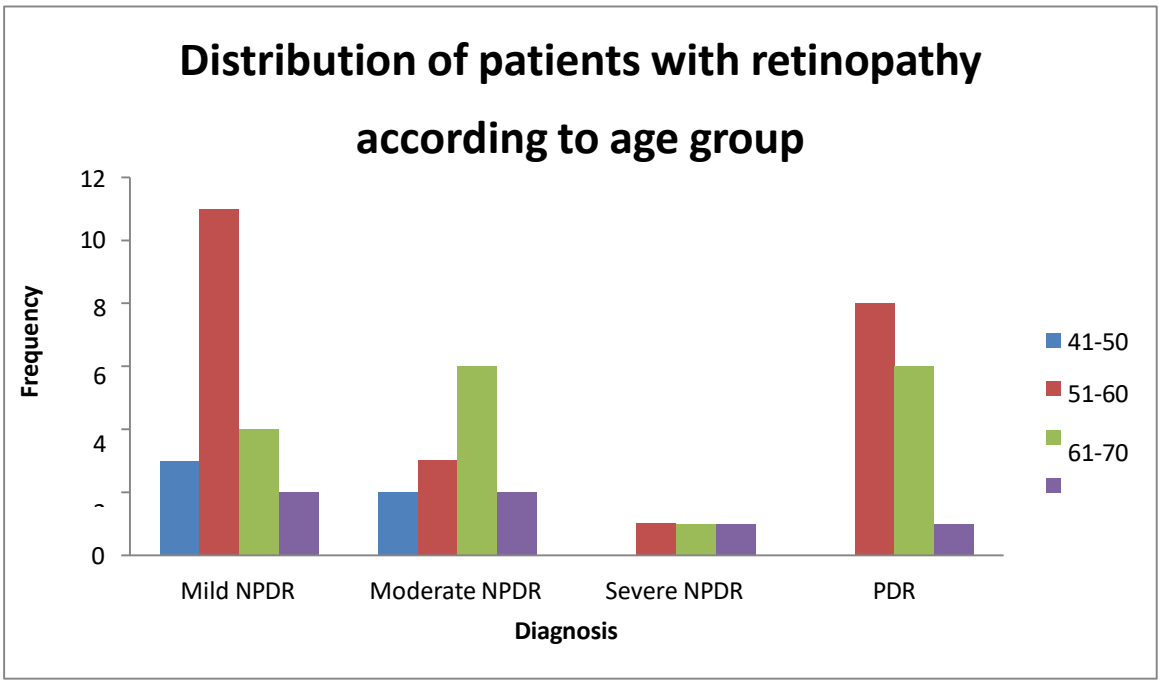

Figure 1: Distribution of Patients with Retinopathy According to Age Group

Table 3: Comparison Of Type Of Retinopathy With Duration And Glycemic Control

		Mild NPDR(%)	Moderate NPDR (%)	Severe NPDR(%)	PDR(%)	Total(%)	CSME (%)
Duration Of DM In Years	<5	04 (20)	03(23.07)	01(33.33)	00(0)	08(15.68)	01(8.34)
	5-10	10 (50)	06 (46)	01(33.33)	07(46.66)	24(47.05)	07(58.33)
	>10	06(30)	04(30.76)	01(33.33)	08(53.33)	19(37.25)	04(33.33)
HBA1C (Control)	<6 % (Excellent)	03(100	00 (0)	00 (0)	03(100)	0(0)	00(0
	6-8 % (Good)	13 (68.42)	02 (10.52)	01 (5.26)	03 (15.78)	19 (100)	03 (25)
	8.1-10 % (Fair)	04 (22.22)	07 (38.89)	01 (5.56)	06 (33.33)	18 (100)	04 (33.33)
	>10 % (Poor)	00 (0)	04 (36.37)	01 (9.09)	06 (54.54)	11 (100)	05 (41.67)

DISCUSSION

Diabetes mellitus is a rapidly growing metabolic disorder worldwide and is strongly associated with multiple ocular complications that significantly affect visual morbidity and quality of life.[19] Chronic hyperglycemia leads to microvascular damage, oxidative stress, inflammation, and accumulation of advanced glycation end products, all of which contribute to structural and functional alterations in ocular tissues.[20] Diabetic eye disease is increasingly recognized as a major public health problem due to its rising prevalence and potential to cause preventable blindness.[21]

In the present study, cataract was the most common ocular manifestation observed, followed by diabetic retinopathy, dry eye disease, and lid-related disorders. Cataract formation in diabetic patients is accelerated due to osmotic stress from sorbitol accumulation via the polyol pathway, leading to lens fiber damage and opacification.[22] Similar findings have been reported in large population-based studies where diabetic patients demonstrated a significantly higher risk of early-onset and rapidly progressing cataracts compared to non-diabetic individuals.[23] The predominance of mixed-type cataracts observed in our study is consistent with findings from previous Indian studies, suggesting that multiple

biochemical pathways may contribute to lens opacity in diabetic populations.[24]

Diabetic retinopathy was the second most frequent complication observed, and its severity was found to increase with the duration of diabetes and poor glycemic control. This observation is in agreement with the landmark findings of the Diabetes Control and Complications Trial (DCCT) and the UK Prospective Diabetes Study (UKPDS), both of which established a strong relationship between chronic hyperglycemia and microvascular complications including retinopathy.[25,26] The progression from non-proliferative diabetic retinopathy (NPDR) to proliferative diabetic retinopathy (PDR) in long-standing diabetes highlights the importance of early screening and strict glycemic control.[27]

Dry eye disease observed in the present study may be attributed to reduced tear secretion and inflammatory changes in the lacrimal glands secondary to autonomic neuropathy and ocular surface damage.[28] Lid disorders such as blepharitis and recurrent stye were also noted, which may be associated with impaired immunity and poor glycemic control in diabetic individuals.[29] These findings emphasize that diabetes affects both anterior and posterior segments of the eye, necessitating comprehensive ophthalmic evaluation.

A statistically significant association was observed between duration of diabetes and ocular complications, with higher prevalence of retinopathy in patients with longer disease duration. Similar trends have been reported in epidemiological studies where duration of diabetes was identified as one of the strongest predictors of diabetic retinopathy.[30] Gender-based variations observed in our study, with a slightly higher prevalence of retinopathy among males, are consistent with some regional studies, although global literature shows mixed results regarding gender predisposition.[31]

Hypertension was the most common associated systemic condition, further increasing the risk of diabetic retinopathy progression due to combined microvascular damage.[32] The coexistence of multiple risk factors such as hypertension, dyslipidemia, and poor glycemic control underscores the multifactorial nature of diabetic ocular complications.

Overall, the findings of this study reinforce the importance of early detection, regular ophthalmic screening, and strict metabolic control in preventing vision-threatening complications in patients with Type 2 diabetes mellitus. Integrated care involving physicians and ophthalmologists is essential for optimal management and prevention of diabetic eye disease.

CONCLUSION

The present study demonstrated that ocular manifestations are highly prevalent among patients with Type 2 diabetes mellitus and are strongly influenced by the duration of diabetes and level of glycemic control. Cataract emerged as the most common ocular complication, followed by diabetic retinopathy, dry eye disease, and lid-related disorders, indicating that both anterior and posterior segment involvement are frequent in diabetic patients.

A significant association was observed between poor glycemic control and the severity of ocular complications, particularly diabetic retinopathy, which increased with longer duration of diabetes. These findings highlight that chronic hyperglycemia plays a crucial role in the development and progression of vision-threatening complications.

The study emphasizes the importance of early detection through regular comprehensive ophthalmological examination in all diabetic patients, irrespective of symptoms. Strict glycemic control along with management of associated systemic risk factors such as hypertension and dyslipidemia can significantly reduce the burden of diabetic eye disease. Early intervention and multidisciplinary care involving physicians and ophthalmologists are essential to prevent avoidable visual impairment and improve overall quality of life in patients with Type 2 diabetes mellitus.

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