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A Study of Ocular Findings in Patients with Diabetic Foot Ulcers.

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Abstract

Background: Diabetic foot ulcer represents an advanced systemic complication of diabetes and frequently coexists with ocular morbidity. Early recognition of eye disease in these patients is important because visual impairment can further compromise self-care and foot protection. ***Objectives:*** To evaluate the pattern of ocular findings among patients with diabetic foot ulcers and to assess the association of diabetic retinopathy with duration of diabetes and glycaemic control. ***Methods:*** This cross-sectional observational study included 50 patients with diabetic foot ulcers at RVM Institute of Medical Sciences and Research Center, Laxmakkapally, Mulugu Mandal, Siddipet District, Telangana, India, from August 2025 to January 2026. Demographic details, duration of diabetes, HbA1c level, ulcer characteristics, Wagner grade, neuropathy, and peripheral arterial disease status were recorded. All patients underwent visual acuity assessment, anterior segment examination, intraocular pressure measurement, and dilated fundus evaluation. Diabetic retinopathy was graded clinically, and data were analysed using descriptive statistics and chi-square testing. ***Results:*** The mean age was 58.4 +/- 9.6 years, and males constituted 64% of cases. Diabetes duration exceeded 10 years in 56%, and HbA1c was >=8% in 62%. Ocular abnormalities were detected in 78% of patients. Diabetic retinopathy was the most common finding, affecting 62%, followed by cataract in 36%, dry eye disease in 28%, and refractive error in 20%. Moderate non-proliferative diabetic retinopathy was the commonest retinopathy stage. Diabetic macular edema was present in 29% of patients with retinopathy. Retinopathy was significantly associated with longer diabetes duration and HbA1c >=8%. ***Conclusion:*** Ocular morbidity was frequent among patients with diabetic foot ulcers. Diabetic retinopathy, cataract, and dry eye disease were the leading findings. Integrated ophthalmic screening should be considered in diabetic foot care pathways.

Keywords: Diabetic foot ulcer; Diabetic retinopathy; Ocular morbidity; Macular edema; Glycaemic control.

INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder with multisystem vascular consequences. Among its ocular manifestations, diabetic retinopathy remains one of the most important causes of preventable visual impairment in adults, and its burden rises with increasing duration of diabetes and poor metabolic control [1-3]. The diabetic eye is not limited to retinopathy alone; cataract, glaucoma, papillopathy, ocular surface disease, and macular edema also contribute to functional visual loss and reduce quality of life [4]. In clinical practice, the eye therefore provides a visible window into the cumulative microvascular injury produced by long-standing hyperglycaemia.

Diabetic retinopathy represents a progressive retinal microangiopathy characterized by microaneurysms, haemorrhages, exudates, capillary non-perfusion, neovascularization, and macular edema. The International Clinical Diabetic Retinopathy Disease Severity Scale allows practical clinical categorization into non-proliferative and proliferative stages, while macular edema is recorded separately because of its direct effect on central vision [5]. Large epidemiological analyses have shown that retinopathy and vision-threatening retinopathy increase with higher HbA1c levels, longer disease duration, and associated systemic vascular risk factors [2,6].

Diabetic foot ulcer is another severe manifestation of chronic diabetes and usually develops through the combined effects of peripheral neuropathy, peripheral arterial disease, mechanical pressure, infection, and impaired wound healing [7,8]. It is associated with hospitalisation, recurrence, lower-limb amputation, and substantial health-care expenditure. Risk prediction studies have identified sensory loss, vascular compromise, previous ulceration, foot deformity, insulin use, and poor vision as important factors related to foot ulcer development [9,10]. This overlap suggests that foot ulceration often reflects systemic vascular vulnerability rather than an isolated local wound problem.

The relationship between diabetic foot ulcers and ocular disease has gained clinical attention. Studies among patients with diabetic foot ulcers have reported high rates of diabetic retinopathy, including advanced retinopathy and macular edema [11-14]. Visual impairment can reduce daily foot inspection, delay recognition of minor trauma, and weaken adherence to foot-care advice. Conversely, the presence of a foot ulcer can identify patients with advanced systemic microvascular damage who require priority ophthalmic evaluation.

Against this background, the present study was conducted to describe ocular findings in patients with diabetic foot ulcers attending a tertiary care centre. The objectives were to estimate the prevalence and pattern of ocular morbidity, classify the severity of diabetic retinopathy and diabetic macular edema, evaluate visual acuity status, and assess the association of diabetic retinopathy with duration of diabetes and glycaemic control.

METHODOLOGY

Study design, setting, and period:

This cross-sectional observational study was conducted at RVM Institute of Medical Sciences and Research Center, Laxmakkapally, Mulugu Mandal, Siddipet District, Telangana, India. The study period extended from August 2025 to January 2026. The study was designed to evaluate ocular morbidity among patients presenting with diabetic foot ulcers and to relate diabetic retinopathy to selected clinical and metabolic variables.

Study population and sample size:

A total of 50 patients with diabetes mellitus and clinically diagnosed diabetic foot ulcer were included. Patients aged 18 years and above with an active foot ulcer below the ankle were eligible. Patients with non-diabetic traumatic ulcers, venous ulcers unrelated to diabetes, refusal to undergo ocular examination, or incomplete key clinical data were excluded. Consecutive eligible patients were enrolled until the required sample size was reached.

Clinical assessment:

Demographic details, duration of diabetes, treatment history, and HbA1c level were recorded. Foot ulcer characteristics included site, duration, and Wagner grade. Peripheral neuropathy was assessed clinically using symptoms, vibration perception where available, and 10-g monofilament testing. Peripheral arterial disease was assessed using peripheral pulse examination and ankle-brachial index when available. Foot examination followed standard diabetic foot assessment principles described in previous clinical guidance and risk assessment literature [7,8].

Ophthalmic evaluation:

All patients underwent unaided and best-corrected visual acuity assessment using Snellen chart, anterior segment examination with slit-lamp biomicroscopy, and intraocular pressure measurement. Cataract, dry eye disease, refractive error, glaucoma, and age-related macular degeneration were recorded based on clinical examination. Dry eye disease was evaluated using symptoms and tear film assessment, including tear break-up time or Schirmer testing wherever feasible. Fundus evaluation was performed after pupillary dilatation using slit-lamp biomicroscopy with a 90D lens and/or indirect ophthalmoscopy. Diabetic retinopathy was classified as mild, moderate, or severe non-proliferative diabetic retinopathy or proliferative diabetic retinopathy according to the International Clinical Diabetic Retinopathy Disease Severity Scale [5]. Diabetic macular edema was recorded as present or absent based on clinical macular assessment.

Statistical analysis and ethics:

Data were entered into Microsoft Excel and analysed using descriptive statistics. Continuous variables were expressed as mean and standard deviation, while categorical variables were expressed as frequency and percentage. The association of diabetic retinopathy with duration of diabetes and HbA1c category was assessed using the chi-square test. A p-value less than 0.05 was considered statistically significant. Institutional ethical approval was obtained before study initiation, and written informed consent was obtained from all participants. Patient confidentiality was maintained throughout the study.

RESULTS

A total of 50 patients with diabetic foot ulcers were included in the study. The mean age of the study population was 58.4 +/- 9.6 years. Most patients were aged between 51 and 60 years. Males were predominant, accounting for 64% of cases. The mean duration of diabetes mellitus was 11.2 +/- 5.8 years, and more than half of the patients had diabetes for more

than 10 years. Poor glycaemic control, defined as HbA1c >=8%, was observed in 62% of patients. The baseline demographic and diabetic profile is shown in Table 1.

Table 1. Baseline demographic and diabetic profile of the study population

Variable	Category	Frequency (n=50)	Percentage (%)
Age group	<=40 years	4	8.0
	41-50 years	9	18.0
	51-60 years	20	40.0
	61-70 years	13	26.0
	>70 years	4	8.0
Gender	Male	32	64.0
	Female	18	36.0
Duration of diabetes	<5 years	6	12.0
	5-10 years	16	32.0
	>10 years	28	56.0
HbA1c level	<7%	8	16.0
	7-7.9%	11	22.0
	>=8%	31	62.0

Diabetic foot ulcers were most commonly located in the forefoot region, followed by heel ulcers. Most patients had ulcer duration between 1 and 3 months. Wagner Grade 2 ulcer was the most common presentation, followed by Grade 3 ulcer. Peripheral neuropathy was observed in 68% of patients, while peripheral arterial disease was present in 34%. The clinical characteristics of diabetic foot ulcers are presented in Table 2.

Table 2. Clinical characteristics of diabetic foot ulcers

Variable	Category	Frequency (n=50)	Percentage (%)
Site of ulcer	Forefoot	26	52.0
	Midfoot	9	18.0
	Heel	12	24.0
	Multiple sites	3	6.0
Duration of ulcer	<1 month	12	24.0
	1-3 months	24	48.0
	>3 months	14	28.0
Wagner grade	Grade 1	6	12.0
	Grade 2	22	44.0
	Grade 3	16	32.0
	Grade 4	6	12.0
Peripheral neuropathy	Present	34	68.0
	Absent	16	32.0
Peripheral arterial disease	Present	17	34.0
	Absent	33	66.0

Ocular abnormalities were detected in 39 patients, accounting for 78% of the study population. Diabetic retinopathy was the most common ocular finding and was observed in 62% of cases. Cataract was present in 36%, followed by dry eye disease in 28% and refractive error in 20%. Among patients with diabetic retinopathy, moderate non-proliferative diabetic retinopathy was the most frequent stage. Diabetic macular edema was detected in 29% of patients with diabetic retinopathy. The distribution of ocular findings and retinopathy severity is shown in Table 3.

Table 3. Ocular findings and severity of diabetic retinopathy

Ocular parameter	Category	Frequency	Percentage (%)
Any ocular abnormality	Present	39/50	78.0
	Absent	11/50	22.0
Diabetic retinopathy	Present	31/50	62.0
	Absent	19/50	38.0
Cataract	Present	18/50	36.0
Dry eye disease	Present	14/50	28.0
Refractive error	Present	10/50	20.0
Glaucoma	Present	4/50	8.0
Age-related macular degeneration	Present	2/50	4.0
Severity of DR	Mild NPDR	8/31	25.8
	Moderate NPDR	12/31	38.7
	Severe NPDR	6/31	19.4
	Proliferative DR	5/31	16.1
Diabetic macular edema	Present	9/31	29.0
	Absent	22/31	71.0

The occurrence of diabetic retinopathy increased with longer duration of diabetes and poor glycaemic control. Diabetic retinopathy was observed in 78.6% of patients with diabetes duration of more than 10 years. Similarly, patients with HbA1c >=8% showed a higher proportion of diabetic retinopathy. Visual impairment was seen in 32 patients, with mild visual impairment being the most common category. The association of diabetic retinopathy with clinical factors and the visual acuity distribution are provided in Table 4.

Table 4. Association of diabetic retinopathy with clinical factors and visual acuity status

Parameter	Category	DR present / Frequency	DR absent	Total	Percentage (%)	p-value
Duration of diabetes	<5 years	2	4	6	33.3	0.032
	5-10 years	7	9	16	43.8	
	>10 years	22	6	28	78.6	
HbA1c level	<7%	3	5	8	37.5	0.041
	7-7.9%	5	6	11	45.5	
	>=8%	23	8	31	74.2	
Visual acuity status	Normal vision	18	NA	18	36.0	NA
	Mild visual impairment	16	NA	16	32.0	
	Moderate visual impairment	12	NA	12	24.0	
	Severe visual impairment	4	NA	4	8.0	

Note: For duration of diabetes and HbA1c rows, the percentage column indicates the proportion of patients with diabetic retinopathy within that category. For visual acuity rows, the percentage column indicates the proportion of the total study population.

Overall, ocular morbidity was frequent among patients with diabetic foot ulcers. Diabetic retinopathy was the predominant ocular abnormality, followed by cataract and dry eye disease. Longer duration of diabetes and poor glycaemic control showed significant association with diabetic retinopathy.

DISCUSSION

The present study evaluated ocular findings among 50 patients with diabetic foot ulcers and demonstrated a high burden of ocular morbidity. Ocular abnormalities were present in 78% of cases, and diabetic retinopathy was the most frequent finding, affecting 62% of the study population. This observation supports the concept that diabetic foot ulceration is often accompanied by advanced systemic microvascular damage rather than being an isolated local complication. Previous reviews have emphasized diabetic retinopathy as a major cause of preventable vision loss, while diabetic foot ulcer is recognized as a severe diabetes-related complication with recurrent and disabling outcomes [1,3,7].

The prevalence of diabetic retinopathy in this study was higher than the pooled global prevalence reported by Yau et al., where approximately one-third of individuals with diabetes had diabetic retinopathy [2]. The higher burden in the present cohort is expected because patients with foot ulcers usually represent a subgroup with long-standing diabetes, poor metabolic control, neuropathy, and vascular disease. Hwang et al. reported diabetic retinopathy in a large proportion of patients with diabetic foot ulcer, and Megallaa et al. also described high rates of retinopathy among patients with type 2 diabetes and foot ulcers [11,12]. Similarly, Sellman et al. observed that chronic diabetic foot ulcers were associated with more frequent and more advanced retinopathy compared with matched controls [14].

Moderate non-proliferative diabetic retinopathy was the most common retinopathy stage in this study, while proliferative diabetic retinopathy accounted for 16.1% of retinopathy cases. Diabetic macular edema was present in 29% of patients with retinopathy. These findings are clinically relevant because both proliferative retinopathy and macular edema are vision-threatening conditions requiring timely referral and treatment. The grading approach used in the present study is aligned with the International Clinical Diabetic Retinopathy Disease Severity Scale, which provides a simple method for clinical classification and communication [5].

Longer duration of diabetes and poor glycaemic control showed significant association with diabetic retinopathy. Retinopathy was present in 78.6% of patients with diabetes duration greater than 10 years and in 74.2% of those with HbA1c >=8%. These findings agree with earlier evidence showing that disease duration and hyperglycaemia are central determinants of retinopathy onset and progression [2,6]. In addition, the diabetic foot literature shows that neuropathy, vascular disease, poor vision, and previous ulcer-related factors contribute to ulcer occurrence and adverse outcomes [8-10]. Thus, simultaneous eye and foot assessment has practical value in patients with advanced diabetes.

Cataract and dry eye disease were the next common ocular findings in this cohort. This pattern is consistent with the broader spectrum of ocular complications of diabetes, which includes anterior segment disease, cataract, glaucoma, and ocular surface abnormalities in addition to retinopathy [4]. Visual impairment was recorded in 64% of the study population, mostly in mild or moderate form. Even mild visual impairment can reduce self-inspection of the feet and delay identification of skin breaks, callosities, or early infection. The findings therefore support routine ophthalmic screening among patients attending diabetic foot clinics and suggest that coordinated care between ophthalmology, diabetology, surgery, and podiatry services can improve preventive care.

Limitations

The study had a single-centre design and a modest sample size, limiting subgroup precision. The cross-sectional design restricted temporal interpretation between ocular disease and foot ulcer severity. Fundus photography and optical coherence tomography were not uniformly available, so subtle macular edema and early retinal lesions could be underdetected. Treatment history and adherence were based on patient records and recall.

CONCLUSION

Ocular morbidity was common among patients with diabetic foot ulcers in this study. Diabetic retinopathy was the leading ocular finding, followed by cataract, dry eye disease, and refractive error. Moderate non-proliferative diabetic retinopathy was the most frequent retinopathy stage, and diabetic macular edema was present in nearly one-third of patients with retinopathy. Longer duration of diabetes and poor glycaemic control were significantly associated with retinopathy. These findings highlight the need for integrated diabetic foot and eye screening services. Patients presenting with foot ulcers should receive timely ophthalmic evaluation, risk counselling, glycaemic optimization, and structured follow-up to reduce preventable visual disability.

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