

Prevalence Risk Factors for Dry Eye Syndrome among Type 2 Diabetes Mellitus Patients

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Abstract

Background: Type 2 diabetes mellitus is a complex condition characterized by elevated blood sugar levels due to impaired insulin secretion or insulin resistance. Ocular complications associated with diabetes, such as diabetic retinopathy and other corneal abnormalities, can have severe consequences, including vision loss. Dry eye disease is a prevalent condition among diabetic patients, with approximately 50% experiencing its symptoms. This study aims to determine the prevalence of dry eye in patients with type 2 diabetes and explore its association with diabetes duration and glycemic control.

Methods: This prospective cross-sectional study conducted at a tertiary hospital in North India aimed to investigate dry eye disorder in patients with type 2 Diabetes Mellitus. A total of 400 consecutive patients were included, meeting specific criteria and excluding certain conditions and medication use. The study involved interviews, demographic data collection, medical history review, general and systemic examinations, ocular examinations, and diagnostic tests. Statistical analysis was performed using SPSS software, and a p-value of less than 0.05 was considered statistically significant.

Results: The study included 384 patients, with a mean age of 61.32 years. The majority of participants were male (71.1%), and the average duration of diabetes mellitus was 10.23 years. The prevalence of dry eye based on the Dry Eye Workshop dry eye severity level grading system was 16.9% for mild dry eye and 2.1% for moderate dry eye. The study found a significant association between the duration of diabetes and dry eye, with a higher prevalence observed in patients with longer diabetes duration. Similarly, the severity of retinopathy was significantly associated with dry eye, with higher rates observed in patients with more severe retinopathy.

Conclusion: In conclusion, our study strongly supports the existence of a significant association between diabetes mellitus and dry eye. Early diagnosis, timely treatment, and effective management of diabetes are vital in improving patient outcomes and enhancing their overall ocular health and well-being.

Keywords: Diabetes Mellitus, Dry eye, Tear film, Retinopathy, Ocular surface.

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Introduction

Type 2 diabetes mellitus is a complex condition characterized by high blood sugar levels due to impaired insulin secretion or insulin resistance in peripheral tissues. It is a multi-factorial disease with various factors contributing to its development [1]. The ocular complications associated with diabetes can be severe and may even lead to blindness. These complications include diabetic retinopathy, neovascular glaucoma, cataracts, refractive errors, ptosis, and cranial nerve palsies [2]. Diabetic patients often experience a range of corneal complications, such as superficial punctate keratopathy, corneal ulceration, and persistent epithelial defects. Many of them also report a sensation of a foreign body in the eye, indicating the presence of tear film abnormalities [3]. Several

studies have highlighted qualitative and quantitative abnormalities in the tear film of diabetic patients, but the exact role of these abnormalities in the development of dry eye disease is still not well understood. Unfortunately, ocular surface examination is frequently overlooked, with more emphasis placed on retinopathy [4].

A comprehensive review of the literature reveals that dry eye disease is prevalent in approximately 50% of patients with diabetes mellitus [5,6]. In a study conducted by Manaviat et al., it was found that 54.3% of diabetic patients had dry eye disease [7].

These statistics emphasize the importance of early detection and treatment of dry eye in diabetic

patients. To address this issue, our study aimed to determine the prevalence of dry eye in patients with type 2 diabetes mellitus and investigate its association with the duration of diabetes and glycemic control. Since there is a lack of research on the prevalence of dry eye and ocular surface disorders in diabetic patients in India, our study sought to fill this gap and provide valuable insights into the condition among the Indian population.

By assessing the prevalence of dry eye and its relationship with diabetes duration and glycemic control, our study aims to contribute to the understanding and management of dry eye disease in diabetic patients. Early identification of dry eye is crucial for initiating timely treatment and preventing further complications.

Materials and Methods

This prospective cross-sectional study was conducted over a period of 2 years (January 2021 to December 2022) at a tertiary hospital of North India. Prior to the initiation of the study, ethical approval was obtained from the Institutional Ethical Committee. Informed consent was obtained from all participating patients.

The study enrolled patients (with a minimum history of five years or more since being diagnosed with type 2 Diabetes Mellitus) who presented to the ophthalmology outpatient department with symptoms of ocular surface disturbance (such as grittiness, itching, burning sensation, early morning stickiness, redness, watering, and photophobia). So, a total of 400 consecutive patients were included in the study during defined study period. However, patients who were cigarette smokers, contact lens users, had a history of refractive surgery, or suffered from conditions such as atopy, Sjogren's syndrome, Rheumatoid arthritis, Parkinson's disease, lupus, as well as those on specific medications like antihistamines, tricyclic antidepressants, oral contraceptives, anti-hypertensives, and diuretics, were excluded from the study. The procedure involved conducting interviews with enrolled patients to gather demographic data and obtain a detailed medical history. This was followed by general and systemic examinations. The diagnosis of dry eye disorder was suspected based on the presence of ocular symptoms described earlier, along with other indicators such as blurred vision that improved with blinking and early morning stickiness. Ocular examinations included recording visual acuity using Snellen's chart and conducting slit-lamp

biomicroscopic examinations to assess the condition of the eyelids, meibomian glands, and conjunctival surfaces. The cornea was evaluated for its sheen, surface condition (such as superficial punctate keratitis, filamentary keratitis, mucous plaques), and sensitivity. Additionally, a detailed fundus examination using direct and indirect ophthalmoscopy was performed to grade any diabetic retinopathy present. DR was graded accordingly to ETDRS criteria.

The diagnosis of dry eye was confirmed through ocular surface dye staining using fluorescein and lissamine green stains. Patients also completed the Ocular Surface Disease Index questionnaire, and three diagnostic tests were conducted: Schirmer's Test (a result of less than 10mm in 5 minutes was considered positive), tear film break-up time (a result of less than 10sec was considered positive), and tear meniscus height mean (TMH) measurements (values of less than 0.25 mm were considered positive) [8]. A diagnosis of dry eye was established if one or more of these tests yielded positive results, and the severity of dry eye was graded according to the Dry Eye Workshop dry eye severity level grading system [9].

For statistical analysis, a random sampling technique was employed to categorize patients into the two groups (dry eye v/s normal eye). The chi-square test was utilized to calculate p-values. Microsoft Excel 2017 was used to create tables, and the article file was prepared using Microsoft Word 2017. Statistical analysis was performed using SPSS software version 26. A p-value less than 0.05 was considered statistically significant.

Results

The study involved a total of 400 participants, but the completeness of data was available for 384 patients, so analysis was done for 384 patients. The mean age of patients was 61.32 ± 7.85 years. The participants had an average duration of diabetes mellitus of 10.23 ± 5.48 years. In terms of gender distribution, 273 participants (71.1%) were male, while 111 participants (28.9%) were female. Regarding tear break-up time (TBUT), 23 participants (6.0%) had a TBUT of less than 10 seconds. The Schirmer test results showed that 58 participants (15.10%) had a measurement of 10 mm or more. 8.6% of patients had a positive fluorescein staining pattern, indicating signs of staining. Similarly, 8.9% of patients had a positive Lissamine staining pattern in the interpalpebral area (Table 1).

Table 1: Baseline characteristics of the patients

Variables	Number	%
Mean Age (in years)	61.32±7.85	
Mean duration of DM (in years)	10.23±5.48	
Gender		
Male	273	71.1
Female	111	28.9
TBUT		
<10 seconds	23	6.0
>10 seconds	361	94.0
Schirmer test		
<10 mm	326	84.9
>10 mm	58	15.1
Fluorescein Staining Pattern		
Negative	351	91.4
Positive	33	8.6
Issamine staining Pattern (interpallebral area)		
Negative	350	91.1
Positive	34	8.9

Based on the Schirmer test results, the grading of dry eye was determined for the left and right eyes of the participants. In the left eye, 8.1% of participants had mild dry eye, 1.0% of patients had moderate dry eye (4, 1.0%). None of the participants had severe dry eye in the left eye. Similar patterns were observed in the right eye, 50 participants (13.0%) with mild dry eye, and 8 participants (2.1%) with moderate dry eye. No participants were found to have severe dry eye in the right eye (Table 2).

Table 2: Grading of dry eye among patients based on Schirmer test

Grade of dry eye based on Schirmer test	Left eye	Right eye
	N (%)	N (%)
Normal	349 (90.9)	326 (84.9)
Mild	31 (8.1)	50 (13.0)
Moderate	4 (1.0)	8 (2.1)
Severe	0 (0.0)	0 (0.0)

Mild dry eye was observed in 65 participants (16.9%), while 2.1% of patients had moderate dry eye. These findings indicate that dry eye was present in a significant portion of the participants, with the majority experiencing no dry eye, followed by a smaller percentage having mild dry eye and a very small percentage exhibiting moderate dry eye (Table 3).

Table 3: Prevalence of dry eye among patients based on Dry Eye Workshop dry eye severity level grading system

Prevalence of dry eye	Number	%
No	311	81
Mild	65	16.9
Moderate	8	2.1

The duration of DM was found to have a significant association with dry eye ($p < 0.0001$). Among those with DM for less than 10 years ($n=320$), 44 participants (13.8%) had dry eye. In the groups with DM duration of 10-15 years, 16-20 years, and over 20 years, the prevalence of dry eye increased, with percentages of 44.4%, 45.5%, and 50.0% respectively. The severity of retinopathy also showed a significant association with dry eye ($p < 0.0001$). Participants with normal retinopathy ($n=208$) had a very low prevalence of dry eye (1.4%), while those with mild non-proliferative diabetic retinopathy (NPDR), moderate NPDR, severe NPDR, and proliferative diabetic retinopathy (PDR) had higher rates of dry eye, with percentages

of 22.7%, 54.5%, 71.4%, and 84.6% respectively. These findings suggest that longer duration of DM and more severe retinopathy are associated with a higher prevalence of dry eye among the participants. Although the prevalence of dry eye was higher in females (22.5%) as compared to the males (17.6%), but the gender was not found to be a significant factor in the prevalence of dry eye in the present study ($p=0.263$). The study demonstrated an increased prevalence of dry eye with advancing age, where 21.8% of patients were falling within the age group of 40 years or more, whereas 12.9% of patients were in the age group >40 years of age group (Table 4).

Table 4: Association of the dry eye with the baseline characteristics of the patients.

Variables	Dry eye N (%)		P value
	Yes (n=73)	No (n=311)	
Duration of DM			
<10 years (n=320)	44 (13.8)	276 (86.3)	<0.0001
10-15 years (n=45)	20 (44.4)	25 (55.6)	
16-20 years (n=11)	5 (45.5)	6 (54.5)	
>20 years (n=8)	4 (50.0)	4 (50.0)	
Severity of retinopathy			
Normal (n=208)	3 (1.4)	205 (98.6)	<0.0001
Mild NPDR (n=110)	25 (22.7)	85 (77.3)	
Moderate NPDR (n=33)	18 (54.5)	15 (45.5)	
Severe NPDR (n=7)	5 (71.4)	2 (28.6)	
PDR (n=26)	22 (84.6)	4 (15.4)	
Gender			
Male (n=273)	48 (17.6)	225 (82.4)	0.263
Female (n=111)	25 (22.5)	86 (77.5)	
Age group			
<40 years (n=108)	14 (12.9)	94 (87.1)	0.058
40 years or more (n=276)	59 (21.8)	217 (78.6)	

The table provides the distribution of mild and moderate dry eye based on the duration of diabetes mellitus (DM) and the severity of retinopathy. Among those with mild dry eye (n=65), the majority had a duration of DM less than 10 years (41, 12.8%), followed by 10-15 years (19, 42.2%), 16-20 years (3, 27.3%), and over 20 years (2, 25.0%). In terms of retinopathy severity, participants with mild non-proliferative diabetic retinopathy (NPDR) had the highest prevalence of

mild dry eye (25, 22.7%), while those with moderate NPDR (18, 54.5%), severe NPDR (5, 71.4%), and proliferative diabetic retinopathy (PDR) (14, 53.8%) also showed notable proportions. As for moderate dry eye (n=8), the distribution across the duration of DM and retinopathy severity categories mirrored that of mild dry eye, with similar percentages observed (Table 5).

Table 5: Distribution of mild and moderate dry eye based on the duration of diabetes mellitus (DM) and the severity of retinopathy among patients

Variables	Number	%	Number	%
	Mild Dry eye (n=65)		Moderate dry eye (n=8)	
Duration of DM				
<10 years (n=320)	41	12.8	3	12.8
10-15 years (n=45)	19	42.2	1	42.2
16-20 years (n=11)	3	27.3	2	27.3
>20 years (n=8)	2	25.0	2	25.0
Severity of retinopathy				
Normal (n=208)	3	1.4	0	1.4
Mild NPDR (n=110)	25	22.7	0	22.7
Moderate NPDR (n=33)	18	54.5	0	54.5
Severe NPDR (n=7)	5	71.4	0	71.4
PDR (n=26)	14	53.8	8	53.8

Discussion

Dry eye syndrome (DES) is a prevalent condition among the general population, affecting approximately 28% of adult patients [10]. Patients with dry eye may experience discomfort such as burning sensation, foreign body sensation, stickiness, watering, red eyes, and blurred vision. In severe cases, it can lead to ocular complications such as keratoepitheliopathy and keratitis.

In terms of diagnostic tests for dry eye, tear break-up time (TBUT) was found to be non-specific for assessing tear film stability. In the present study, TBUT was less than 10 seconds in 6.0% of patients. Schirmer's test without anesthesia, measuring total tear secretion, was less than 10 mm in 15.1% of patients. Fluorescein staining, assessing ocular surface damage, was positive in approximately 8.6% of patients. Schirmer's test was found to be the most accurate diagnostic test, followed by fluorescein staining and tear break-up time. In the

present study, the prevalence of dry eye associated with type 2 diabetes mellitus (DM) was found to be 19.0%. Most cases (16.9%) were classified as mild. These findings are consistent with the study by Hasan et al., which also reported a prevalence of 20% for the mild form [11].

However, other studies showed a varying prevalence rate of dry eye in type 2 diabetes patients, ranging from 19.8% to 70% [12,13,14]. These differences in prevalence can be attributed to variations in sample size, study design, and factors related to the duration, stage, and treatment of diabetes [5,7,13,14,15,16].

The duration of diabetes was found to have a significant influence on the prevalence of dry eye in the present study. Patients with a duration of diabetes exceeding 10 years had a higher prevalence of dry eye, which was statistically significant ($p < 0.0001$). Similar findings were reported in other studies [15,18,19]. Kaiserman et al., emphasized the importance of good blood sugar regulation in preventing and controlling dry eye among diabetic patients [19].

The study demonstrated an increased prevalence of dry eye with advancing age, where 21.8% of patients were falling within the age group of 40 years or more, whereas 12.9% of patients were in the age group >40 years of age group. Kaiserman et al., also reported that the prevalence of dry eye increases with age [19]. Schultz et al, suggested that increased evaporation and tear film osmolarity with age are important factors contributing to dry eyes. Autonomic dysfunction may also play a role in the increased prevalence of dry eyes with age [18].

Although the prevalence of dry eye was higher in females (22.5%) as compared to the males (17.6%), but the gender was not found to be a significant factor in the prevalence of dry eye in the present study ($p = 0.263$). However, Moss et al., reported a higher incidence of dry eyes in diabetic women (16.7%) compared to diabetic men (11.4%) [14].

Regarding the association between dry eye and diabetic retinopathy, Nepp et al., found that the severity of dry eye correlated with the severity of diabetic retinopathy [12]. Manaviat et al., reported a higher prevalence of dry eye with advanced stages of retinopathy [7]. Similarly, the present study found a significant association between dry eye and diabetic retinopathy ($p < 0.0001$).

It is important to note that the study has certain limitations, including a small sample size and a lack of long-term follow-up for dry eye patients. Assessing a larger sample and conducting long-term follow-up would provide a more comprehensive understanding of the significant

associations between type 2 DM, dry eye, and diabetic retinopathy.

Conclusion

In conclusion, our study strongly supports the existence of a significant association between diabetes mellitus and dry eye. Early diagnosis, timely treatment, and effective management of diabetes are vital in improving patient outcomes and enhancing their overall ocular health and well-being. Initiating early treatment for dry eye in individuals with positive diagnoses can prevent potential corneal complications. Therefore, it is essential to closely monitor diabetic patients and strive for optimal blood sugar regulation to prevent the development of dry eye and mitigate the progression of diabetic retinopathy.

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