BENHA MEDICAL JOURNAL bmj
Print ISSN 1110-208X.
Online ISSN 2357-0016

Comparative Study of Dry Eye Disease after Phacoemulsification in Diabetic Patients with Different Stages of Diabetic Retinopathy

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Received: 17 November 2024
Accepted: 12 January 2025

Abstract:

Background: Diabetes mellitus (DM) affects over 240 million people globally, with ocular complications like dry eye disease (DED) being particularly prevalent. DED impacts the quality of life significantly, affecting 52.8% of DM patients compared to 9.3% of healthy individuals. This study aims to evaluate and compare the severity and pattern of DED post-phacoemulsification cataract surgery among non-diabetic patients, diabetics without diabetic retinopathy, and diabetics with diabetic retinopathy and/or macular edema. **Methods:** this cross-sectional study done at Benha University Hospital, 45 patients were divided into three groups (15 each): non-diabetic, diabetic without retinopathy, and diabetic with retinopathy and or macular edema. Comprehensive ocular examinations, including Tear Film Break-Up Time (TBUT), Schirmer I test (SIT), Ocular Surface Disease Index (OSDI), Tear Meniscus Height (TMH), corneal staining, and corneal epithelial thickness by anteing OCT were conducted. **Results:** The mean age was 54.3 ± 6.6 years. Statistically significant differences were found across groups for TBUT (P = .003), SIT (P = .022), OSDI (P = .001), and TMH (P = .031). Specifically, diabetics with retinopathy exhibited the most severe DED, with OSDI scores averaging 45.6 ± 9.4 (P < .001). Corneal staining was significantly higher in diabetic patients (P = .004).Superior corneal epithelial thickness was significantly thinner in diabetic patients (P = .025). **Conclusion:** Post-phacoemulsification cataract surgery, DED incidence is significantly higher in diabetic patients, particularly those with retinopathy and/or macular edema. These findings underscore the need for vigilant monitoring and management of DED in diabetic patients undergoing cataract surgery.

Keywords: Diabetes Mellitus; Dry Eye Disease; Phacoemulsification; Ocular Surface Disease Index; Tear Film Break-Up Time.

Introduction

Diabetes mellitus (DM) is a major global health concern, affecting over 240 million people, with projections rising to 370 million by 2030. Among its numerous complications, ocular issues like dry eye disease (DED), diabetic retinopathy, glaucoma, and cataracts significantly impact quality of life and create substantial economic burdens, with DED being the most prevalent, affecting 52.8% of DM patients compared to 9.3% in healthy individuals [1, 2]. Symptoms of DED include burning, photophobia, and blurred vision, and it can lead to serious corneal complications. DM contributes to decreased tear production and neurotrophic changes that worsen DED, creating a vicious cycle of ocular discomfort [3].

Additionally, type 2 DM leads to corneal nerve fiber abnormalities and reduced blink rates, increasing tear film evaporation. Studies show that cataract surgery can exacerbate diabetic retinopathy, with progression rates influenced by preoperative conditions, duration of DM, and glycemic control, likely due to inflammatory responses triggered by surgical trauma [4].

Inflammatory mediators play a crucial role in the progression of diabetic retinopathy (DR) and the disruption of the blood-retinal barrier, leading to diabetic macular edema (DME). The severity of type 2 DM is important in understanding the pathogenesis of DED, though studies linking the severity of both DR and DED are scarce [5].

Phacoemulsification, a technique pioneered by Charles Kelman in 1967 and refined by 1971, involves using ultrasonic vibrations to break up a cataract for removal, often followed by the insertion of an intraocular lens (IOL) to restore vision [6]. The primary reason for cataract surgery via this method is to improve vision, necessitating preoperative biometry for IOL power calculation, pupil dilation, proper anesthesia, and sterile precautions during the procedure, including the use of an eye speculum [7].

The main aim of this study is to detect and compare the severity and pattern of dry eye post phacoemulsification cataract surgery in non- diabetics, diabetics without diabetic retinopathy or macular edema and diabetics with diabetic retinopathy and, or macular edema.

Patients and methods

Study design

This comparative study was conducted at the ophthalmology department at Benha University Hospital. The field work was carried out during the period from May 1st, 2022 to December 31st, 2022 (8 months). This study was conducted on 45 cases undergoing phacoemulsification cataract surgery. All patients were divided into 3 equal groups (15 cases each): Group A are non-diabetic patients. Group B are diabetic patients without diabetic retinopathy or macular edema. Group C are diabetic patients with diabetic retinopathy and/or macular edema. The study was done after being approved by the Research Ethics Committee, Faculty of Medicine, Benha University (Approval code: M.S.17.4.2022). An informed written consent was obtained from the patients. Every patient received an explanation of the purpose of the study and had a secret code number.

Inclusion criteria were patients with immature senile cataract planned for phacoemulsification surgery, age between 45-70 years.

Exclusion criteria were patients with DED, those with previous refractive procedures, patients with ocular trauma or ocular medical diseases (such as uveitis, glaucoma, corneal disorders and dystrophies, except for the third group having diabetic retinopathy and or macular edema), participants with systemic diseases or taking medications inducing eye dryness except diabetes only for the second and the third groups, and contact lens wearers.

All studied cases were subjected to the following: Detailed history taking**,** Full clinical examination: General examination, Routine laboratory investigations, Radiological investigation **[**Fundus examination, fundus photography, fundus fluorescein angiography and anterior segment OCT**]**, Ocular examination, External eye examination **[**Eye lid skin, for rosacea, seborrhea, lacrimal glands, swelling in the lateral upper lid area, eyelids, ectropion, entropion, lid defect, scars, redness or swelling of lid margin, eyelid closure, voluntary, involuntary, Bell's phenomenon and proptosis**]**.

Technique

The ocular examination involves a thorough external eye assessment and advanced testing to evaluate DED. The external examination checks eyelid conditions, swelling, and function, while slit lamp biomicroscopy measures tear stability through the Tear Film Break-Up Time (TBUT), assesses corneal and conjunctival staining using fluorescein and Rose Bengal, and evaluates tear production via the Schirmer I test (SIT). These tests help categorize tear film health, with specific scores indicating normal to severe dry eye conditions.

Additionally, the Tear Film Meniscus Height (TMH) and the Ocular Surface Disease Index (OSDI) questionnaire provide further insights into tear levels and symptom severity. Advanced imaging with Anterior Segment Optical Coherence Tomography (AS-OCT) assesses corneal epithelial thickness, particularly post-cataract surgery. Together, these methods form a comprehensive approach to diagnosing and managing ocular health, particularly concerning dry eye disease.

Statistical analysis

The statistical analysis was conducted using the Software, Statistical Package for Social Science, (SPSS Inc. Released 2009-PASW Statistics for Windows Chicago: SPSS Inc.) The collected data were summarized in terms of mean ± Standard Deviation (SD) and range (minimum - maximum) for quantitative data and frequency and percentage for qualitative data. The collected data was analyzed using suitable statistical methods. Statistical significance was accepted at P value <0.05. A P value <0.001 was considered highly significant while a P value >0.05 was considered non-significant.

Results

The mean age of enrolled patients was 54.3 ± 6.6 years (range, 45 – 70 years). The mean age of group A was 55.6 ± 6.2 years (range, 45 – 70 years). There was no statistically significant difference was found between groups as regards age, gender, residence, or occupation. Table 1

The three study groups were compared in terms of DED parameters, including TBUT, SIT, OSDI questionnaire, TMH, corneal staining, and epithelial mapping (thickness). The mean TBUT was 8.9 ± 0.7, 7.3 ± 0.6, and 6.2 ± 0.3 seconds in groups A, B, and C, respectively. The mean TBUT was significantly different across the study groups (P = .003). When post-hoc multiple comparisons were performed, groups B and C showed significantly shorter TUBT compared to group A (P = .001 and .004, respectively). Furthermore, group C had significantly shorter TUBT compared to group B (P = .006). Table 2

The mean SIT was 9.0 ± 0.4, 7.5 ± 0.3, and 6.5 ± 0.4 mm in groups A, B, and C, respectively. The mean SIT was significantly different across the study groups (P = .022). When post-hoc multiple comparisons were performed, groups B and C showed significantly lower SIT values compared to group A (P = .021 and .013, respectively). Furthermore, group C had significantly lower SIT values compared to group B (P = .044). The mean OSDI was 14.4 ± 4.2 (mild disease), 27.5 ± 7.3 (moderate disease), and 45.6 ± 9.4 (severe disease) in groups A, B, and C, respectively. Table 2

The mean OSDI was significantly different across the study groups (P = .001). When post-hoc multiple comparisons were performed, groups B and C showed significantly higher OSDI values compared to group A (P = .000 and .001, respectively). Furthermore, group C had significantly higher OSDI compared to group B (P = .018). Table 2

Table 1: Demographic Characteristics

	Group A (N = 15)	**Group B (N = 15)**	**Group C (N = 15)**	**P value**
Age, years				.598*
Mean ± SD	55.6 ± 6.2	53.9 ± 6.6	53.5 ± 7	
Range	45 – 70	46 – 68	48 – 70	
Gender				.806**
Female	4 (27%)	6 (40%)	5 (33%)	
Male	11 (73%)	9 (60%)	10 (67%)	
Residence				.806**
Urban	6 (40%)	5 (33%)	6 (40%)	
Rural	9 (60%)	10 (67%)	9 (60%)	
Occupation				.515**
UV Exposure	10 (67%)	10 (67%)	11 (73%)	
No UV Exposure	5 (33%)	5 (33%)	4 (27%)	

* One Way ANOVA; ** Chi-square test, SD: standard deviation.

Table 2: Parameters of Dry Eye Disease

	Group A (N = 15)	**Group B (N = 15)**	**Group C (N = 15)**	**P value**
TBUT, sec				.003*
Mean ± SD	8.9 ± 0.7	7.3 ± 0.6	6.5 ± 0.4	
Range	7 – 14	5 – 11	4 – 9	
SIT, mm				.022*
Mean ± SD	9.0 ± 0.4	7.5 ± 0.3	6.5 ± 0.4	
Range	8 – 15	5 – 12	3 – 8	
OSDI				.001*
Mean ± SD	14.4 ± 4.2	27.5 ± 7.3	45.6 ± 9.4	
Range	5 – 18	20 – 35	33 – 50	
TMH, mm				.031*
Mean ± SD	0.7 ± 0.2	0.5 ± 0.3	0.2 ± 0.1	
Range	0.6 – 0.8	0.4 – 0.7	0.1 – 0.4	
Positive Corneal Staining				.004**
Positive	5 (33%)	10 (67%)	13 (87%)	
Negative	10 (67%)	5 (33%)	2 (13%)	
Corneal Epithelial Thickness, µm				
Superior	55 ± 3.1	50 ± 2.5	45 ± 3.8	.025*
Central	53 ± 4.3	52 ± 3.5	52 ± 2.2	.321*
Inferior	54 ± 2.2	54 ± 1.8	53 ± 3.2	.072*

TBUT: Tear Film Break-Up Time, SIT: Schirmer I Test, OSDI: Ocular Surface Disease Index, TMH: Tear Meniscus Height, * One Way ANOVA; ** Chi-square test.

The mean TMH was 0.7 ± 0.2, 0.5 ± 0.3, and 0.2 ± 0.1 in groups A, B, and C, respectively. The mean TMH was significantly different across the study groups (P = .031). When post-hoc multiple comparisons were performed, groups B and C showed significantly lower TMH compared to group A (P = .002 and .011,

respectively). Furthermore, group C had significantly lower TMH compared to group B (P = .047). Table 2

Regarding Corneal Staining, five (33%) patients in group A had positive staining, while 10 (67%) patients in group B, and 13 (87%) patients in group C had positive staining. According to corneal staining, the incidence of dry eye disease was significantly higher in diabetic patients compared to non-diabetic patients (P = .004). Table 2

The mean superior thickness was significantly different across the study groups (P = .025). When post-hoc multiple comparisons were performed, groups B and C showed significantly thinner superior corneal thickness compared to group A (P = .022 and .001, respectively). Furthermore, group C had significantly thinner superior thickness compared to group B (P = .037). No statistically significant difference was detected between groups regarding central and inferior corneal thickness (P > .05). Table 2

Discussion

Regarding demographic data, the current study showed that the mean age of enrolled patients was 54.3 ± 6.6 years with male predominance 30 (67%) male. The study found no statistically significant difference among groups regarding age and sex. In agreement with the current study [8] revealed that there was no statistically significant difference between diabetic and non- diabetic groups regarding age and sex. The patients aged between 31 and 77 years with a mean of 55±10.1 years, with majority of females (56.8%). Also, [9] found that the mean age of the patients was 59.25+9.77 years and 73 (60.8%) were men. The study also revealed that there was no significant association between age or sex and dry eye after cataract surgery.

Regarding residence, the current study showed that 28 (62%) patients were of rural residence. The study found no statistically significant difference among groups regarding residence. In agreement with the current study [9] revealed that the majority of the studied patients was from rural areas (85%). The study also revealed that there was no significant association between residence and dry eye after cataract surgery.

Regarding occupation, the current study found a total of 31 (69%) patients carried out occupations associated with UV exposure, while 14 (31%) did not. Also, [10] revealed that most of the dry eye patients (41.3%) were household worker, 27% patients were businessmen, 17.5 involved in other works and 14.3% patients were not involve in any work. The study found no statistically significant relation between dry eye in diabetic retinopathy and occupation. Also, [9] showed that there was no significant association between occupation and dry eye after cataract surgery.

According to TBUT, SIT, OSDI, TMH, corneal staining, and corneal epithelial thickness measurements of the study groups the incidence of dry eye disease was significantly higher in diabetic patients compared to non-diabetic patients and more profound in diabetic patients with diabetic retinopathy and or macular edema. (P = .001). Also, [11] showed that there was significant association between diabetes and dry eye. 36% of the diabetic patients had dry eye. Dry eye prevalence increased with increase in the duration of diabetes (p=0.002), poor glycemic control (p=0.005), presence of retinopathy (p=0.002).

Regarding TUBT, the study revealed that diabetic patients had shown shorter TUBT compared to non-diabetic patients and, the presence of diabetic retinopathy and/or macular edema was associated with shorter TUBT. In agreement with our study, [12] showed that the diabetic patients have significantly lower TBUT compared to non-diabetic patients. Furthermore, in agreement with the current study [13] found

statistically significant association between diabetic retinopathy and DED.

In contrast, [14] revealed that the overall presence and severity of dry eye was found to be similar in the diabetic and non-diabetic patient groups. The disagreement may be due to the difference in sample size and inclusion criteria.

Regarding SIT, the study revealed that diabetic patients had shown lower SIT compared to non-diabetic patients. Furthermore, the presence of diabetic retinopathy and/or macular edema was associated with lower SIT (P = .002). Consistent with the current study, [12] showed that the diabetic patients have significantly lower SIT compared to non-diabetic patients. Also, in agreement with the current study [15] revealed that diabetic patients have significantly lower SIT compared to non-diabetic patients, also the Furthermore, the severity diabetic retinopathy was associated with lower SIT. However, [14] showed that the mean Schirmer test scores were not significantly higher for non-diabetic subjects as compared with that in diabetic subjects (P = 0.001), the disagreement may be due to the difference in sample size and inclusion criteria.

According to OSDI, the study revealed that diabetic patients had shown higher OSDI compared to non-diabetic patients also, the presence of diabetic retinopathy and/or macular edema was associated with higher OSDI. (P = .027). In agreement with the current study [8] revealed that the percentage of dry eye symptoms was higher in diabetic subjects (15.9%) compared with non-diabetic subjects (13.6%; p<0.001). The percentage of dry eye symptoms was also higher in diabetics with dry eye (63%) than in diabetics without dry eye (36.9%; p<0.001). Also, [14] revealed that the mean OSDI score was higher in non-diabetic patients as compared with that in diabetic patients.

According to TMH, the study revealed that diabetic patients had shown lower TMH compared to non-diabetic patients and the presence of diabetic retinopathy and/or macular edema was associated with lower TMH (Chi-square test, P = .019). In line with the current study (8) revealed that diabetic patients have lower TMH compared to non-diabetic patients, but without statistical significance. Also, [16] revealed that TMH was significantly lower in the over 10 years diabetic group compared with the control group (P=0.0016) and the 5 years group (P=0.0061).

Regarding corneal staining, the study revealed that diabetic patients had shown higher grades of staining pattern compared to non-diabetic patients, and the presence of diabetic retinopathy and/or macular edema was associated with higher grades of staining patterns. (P = .004). Consistent with the current study, [12] showed that the diabetic patients have significantly higher corneal staining compared to non-diabetic patients. Also, in line with the current study [8] revealed that diabetic patients have higher grades of staining patterns compared to non-diabetic patients.

However, [14] revealed that there was no significant difference between non-diabetic and diabetic patients as regard corneal staining. The disagreement may be due to the difference in study settings.

According to Corneal Epithelial Thickness, the study revealed that diabetic patients had shown thinner superior corneal epithelial thickness compared to non-diabetic patients. Furthermore, the presence of diabetic retinopathy and/or macular edema was associated with thinner superior thickness. No statistically significant difference was detected between groups regarding central and inferior corneal thickness (One Way ANOVA, P > .05) (P = .020). In harmony with the current study [17] showed that the corneal epithelium has been found to decrease in thickness in diabetic patients versus the normal population.

This study has some limitations including: small sample size, being a single center study and relatively short

follow up period. So, further comparative studies with larger sample size and longer follow-up are needed to confirm our results and to identify risk factors of dry eye disease in diabetic patients undergoing phacoemulsification surgery.

Conclusion

The current study showed that incidence of dry eye disease post phacoemulsification cataract surgery was significantly higher in diabetic patients compared to non-diabetic patients. The presence of diabetic retinopathy and/or macular edema was associated with more severe dry eye disease post phacoemulsification cataract surgery.

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To cite this article: Rana A. Gewida, Ahmed E. Daifalla, Mohamed T. Khalil, Husam M. Faramawi. Comparative Study of Dry Eye Disease after Phacoemulsification in Diabetic Patients with Different Stages of Diabetic Retinopathy BMFJ 2025;42(3);228-234.