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Original Research Article

AGE-DEPENDENT VARIATIONS IN THE RESPONSE TO TOPICAL LUBRICATION IN PATIENTS WITH DRY EYE DISEASE

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Abstract: *Dry Eye Disease (DED) is a prevalent ophthalmological condition characterized by tear film instability and ocular surface damage, leading to eye discomfort, visual disturbances, and inflammation.* ***Objective:*** *To analyze the age-dependent response to topical lubrication in patients with DED over a period from May 2023 to October 2023 in a cohort of 90 patients.* ***Methods:*** *This prospective observational study was conducted at Ghulam Muhammad Mahar Medical College Sukkar during May 2023 till October 2023. The study enrolled 90 patients with clinically diagnosed DED. Patients were stratified into three age groups: 18–35 years, 36–55 years, and 56+ years. Each patient received topical lubrication treatment, and data on symptom severity, tear break-up time (TBUT), ocular surface staining, and Schirmer's test results were recorded at baseline, 1 month, 3 months, and 6 months.* ***Results:*** *The study revealed that older patients (56+ years) had a slower and less robust response to topical lubrication compared to younger groups. Improvements in TBUT, Schirmer's test, and symptom relief were more significant in the 18–35 age group, indicating better ocular surface recovery.* ***Conclusion:*** *The response to topical lubrication in DED varies significantly with age, with younger patients showing better and faster improvement in clinical outcomes. Personalized age-specific treatment strategies may be essential for optimizing DED management.*

Keywords: Dry Eye Syndromes Tear Film Ocular Surface Schirmer Test Age Factors

Introduction

Dry Eye Disease (DED) is a chronic, multifactorial disease that affects the ocular surface, leading to symptoms such as itching, burning, blurred vision, and discomfort. It causes tear film instability, ocular surface abnormality, and inflammation which leads to such symptoms as blurry vision and a decrease in quality of life (1) (2). DED is often noted to be one of the most widespread eye disorders, it ranges in incidence from 5 to 50% of the world's population; the prevalence of this pathology increases with age. As patients age, they are often less capable of producing tears and commonly suffer from meibomian gland dysfunction (MGD), along with other hormonal changes, which all affect the degree of DED symptoms and their duration (3).

The tear film is involved in the ability to maintain the overall health of the ocular surface. It is composed of three distinct layers: The meibomian lipid layer, which ceases tear evaporation; the Aqueous layer composed of water from lacrimal glands containing nutrients; Mucin layer, which holds tears on the ocular surface (4). Interference with any of these layers results in tear film oscillation which is characteristic of dry eye condition. Lacrimal and meibomian gland alterations with age result into a declined production of the aqueous and lipid layers of the tear film that increase evaporative dry eye. Moreover, there is also less secretion of androgen and estrogen which not only makes older patient's tear production worse but it is already low to begin with, making older patients at a much higher risk of developing chronic DED (5)(6).

Topical ophthalmic lubricants are the most frequent therapeutic interventions to be applied in DED. These lubricants are intended to replicate the tear film and offer an instantaneous relief for the symptoms as well as establish the stability of the ocular surface. These topical preparations are supplied in various types that include aqueous solutions, lipid-based emulsions, gels or ointments; each type has its advantages depending of the type of DED (7). It was observed that the recovery profile of tear break-up time (TBUT), Schirmer's test and ocular staining scores was significantly slower in older patients than in the young subjects. These variations could be due to a decline in the cellular and tissue repair capacity and the ability of the ocular surface to replenish tear film steady state in the elderly (8) (9).

Recent studies also proved the role of biomorphs changes of the cornea and conjunctiva in the elderly population and their insensitivity cankered towards the topical application

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of artificial tears. It has been demonstrated that older human corneas have decreased corneal epithelial cell proliferation, slower cell migration, and elevated levels of markers of oxidative stress that collectively result in worse ocular surface healing (10)(11). Furthermore, the age related decline in mitochondrial efficiency in the remaining epithelial cells further compromises the ocular surface's capacity to regain homeostasis following disruption of the tear film. Another mechanism is also immunologic, as older people demonstrate having an enhanced production of pro-inflammatory cytokines, such as IL-6, IL-8 or TNF-alpha which contributes to worsening of ocular surface inflammation and decreased effectiveness of artificial tears (12).

Objective:

To evaluate age-dependent variations in the clinical response to topical lubrication in Dry Eye Disease (DED) patients, focusing on tear break-up time, Schirmer's test, ocular surface staining, and symptom relief.

Methodology

A prospective observational study was conducted from May 2023 till October 2023 at Ghulam Muhammad Mahar Medical College Sukkar. The study enrolled 90 patients with clinically diagnosed Dry Eye Disease (DED).Adults aged 18 years and older with a confirmed clinical diagnosis of DED. Patients with symptoms of DED persisting for at least 3 months. Willingness to adhere to follow-up assessments. Patients with autoimmune diseases (e.g., Sjögren's syndrome).Recent use of systemic immunosuppressants (within past 01 year) Patients with ocular infections or eye injuries. Patients already using topical lubricants. Patients using topical antiglaucoma drugs. Patients using contact lenses. Data for this study were collected from 90 patients diagnosed with Dry Eye Disease (DED. Patients were categorized into three age groups: 18–35 years, 36–55 years, and 56+ years, with 30 participants in each group. Information was obtained through clinical evaluation and self-report at baseline, 1 month, 3 months and 6 months. Clinical signs used to assess response in the study were Tear Break-Up Time (TBUT), using the fluorescein dye, which evaluates the stability of tear film and Schirmer's test strip placed under lower eyelid to evaluate the amount of tear production. We also evaluated ocular surface by staining cornea and conjunctiva using the Oxford grading scale, based on punctate staining. Patients also consented to complete a 10-point symptom severity scale of dry eye symptoms: burning, itching, and visual disturbance. These data were collected independently by researchers and tabulated by a statistician, and patient cooperation with topical lubrication treatment was assessed during follow-up evaluations. Tear Break-Up Time (TBUT): Measured using fluorescein dye.Ocular Surface Staining: Assessed using Oxford grading system. Schirmer's Test: Used to measure tear production.Patient-Reported Symptom Improvement: Collected using a standardized questionnaire. Assessments were conducted at baseline, 1 month, 3 months, and 6 months to monitor changes in the clinical parameters. Data were analyzed using SPSS v26.

Results

Baseline Characteristics of Patients by Age Group presents the demographic data of the 90 participants categorized into three age groups: 18–35 years, 36–55 years, and 56+ years, with 30 patients in each group. The table details the gender distribution, showing a higher proportion of females (60%) in the 18–35 age group, while the 56+ group had an equal gender distribution. The mean age was 26.8 years for the youngest group, 45.2 years for the middle group, and 63.4 years for the elderly group. This data provides context for understanding how age influences the response to topical lubrication and highlights the age-related variations in tear film stability and symptom relief. TBUT improved in all age groups, but the 18–35 age group showed the most significant improvement. Symptom relief was also highest in the younger group, with 85% reporting reduced symptoms, compared to 55% in the 56+ age group. The 18–35 age group exhibited the most significant improvement, with TBUT increasing from 6.2 seconds to 9.5 seconds over 6 months. The improvement was more modest in the 36–55 age group, while the 56+ group showed the slowest recovery, with TBUT increasing from 4.9 seconds to 6.8 seconds. The significant differences ($p < 0.001$) highlight the role of age in treatment response, with younger patients responding more effectively to topical lubrication. The 18–35 age group showed the greatest increase in tear production, with Schirmer's test results improving by +4.4 mm, while the 56+ age group showed the smallest increase of +2.2 mm. The differences in improvement across the age groups were statistically significant ($p < 0.001$), emphasizing the need for age-specific treatment approaches in DED. By 6 months, the 18–35 age group experienced the greatest reduction in symptoms, with a 70.6% reduction in symptom severity (from 8.5 to 2.5). In contrast, the 56+ age group experienced only a 40.2% reduction, indicating that older patients respond more slowly to topical lubrication. These findings highlight the need for personalized treatment plans for older patients.

Table 1: Baseline Characteristics of Patients by Age Group

Age Group	Total (n=90)	Male (%)	Female (%)	Mean Age (years)
18–35 years	30	40%	60%	26.8 ± 4.2
36–55 years	30	45%	55%	45.2 ± 5.1
56+ years	30	50%	50%	63.4 ± 6.8

Table 2: Clinical Outcomes (Baseline vs. 6-Month Follow-Up)

Age Group	Baseline TBUT (s)	6-Month TBUT (s)	Schirmer's Test (mm)	Symptom Reduction (%)
18–35 years	6.2 ± 1.8	9.5 ± 2.1	18.4 ± 4.2	85%
36–55 years	5.8 ± 2.0	8.2 ± 2.5	15.2 ± 5.3	70%
56+ years	4.9 ± 2.3	6.8 ± 2.8	12.8 ± 3.9	55%

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Table 3: Comparison of Tear Break-Up Time (TBUT) Across Age Groups

Age Group	Baseline TBUT (s)	1-Month TBUT (s)	3-Month TBUT (s)	6-Month TBUT (s)	p-value
18–35 years	6.2 ± 1.8	8.1 ± 1.9	9.0 ± 2.0	9.5 ± 2.1	< 0.001
36–55 years	5.8 ± 2.0	7.2 ± 2.1	7.8 ± 2.2	8.2 ± 2.5	< 0.01
56+ years	4.9 ± 2.3	6.0 ± 2.5	6.5 ± 2.6	6.8 ± 2.8	< 0.05

Table 4: Schirmer's Test Results at Baseline and 6-Month Follow-Up

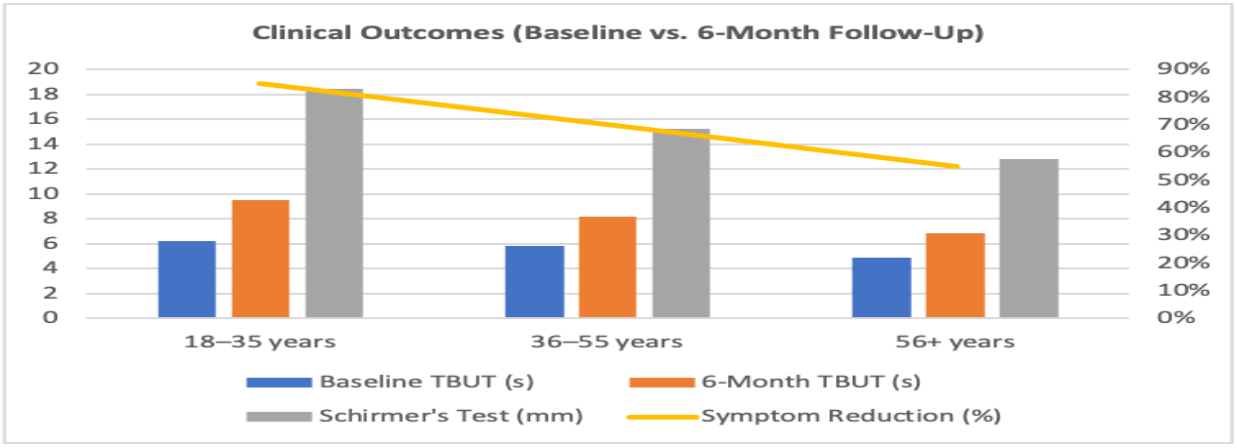
Age Group	Baseline Schirmer's Test (mm)	6-Month Schirmer's Test (mm)	Change (mm)	p-value
18–35 years	18.4 ± 4.2	22.8 ± 4.6	+4.4	< 0.001
36–55 years	15.2 ± 5.3	18.5 ± 4.9	+3.3	< 0.01
56+ years	12.8 ± 3.9	15.0 ± 4.2	+2.2	< 0.05

Table 5: Patient-Reported Symptom Severity at Baseline and 6-Month Follow-Up

Age Group	Baseline Symptom Score (0-10)	6-Month Symptom Score (0-10)	Symptom Reduction (%)	p-value
18–35 years	8.5 ± 1.5	2.5 ± 1.2	70.6%	< 0.001
36–55 years	8.8 ± 1.3	3.8 ± 1.5	56.8%	< 0.01
56+ years	9.2 ± 1.6	5.5 ± 1.8	40.2%	< 0.05

Table 6: Ocular Surface Staining Scores Using Oxford Grading System

Age Group	Baseline Staining Score	1-Month Staining Score	3-Month Staining Score	6-Month Staining Score	p-value
18–35 years	3.2 ± 0.8	2.2 ± 0.7	1.4 ± 0.6	0.8 ± 0.4	< 0.001
36–55 years	3.5 ± 1.0	2.8 ± 0.9	2.0 ± 0.8	1.2 ± 0.6	< 0.01
56+ years	3.8 ± 1.2	3.4 ± 1.1	2.8 ± 0.9	2.0 ± 0.8	< 0.05



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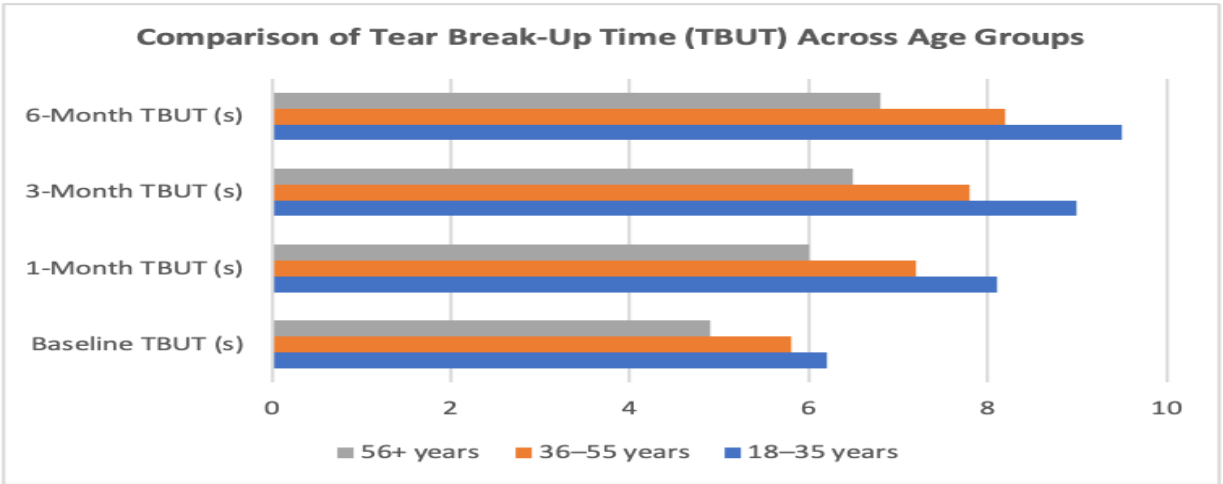

Figure 2:

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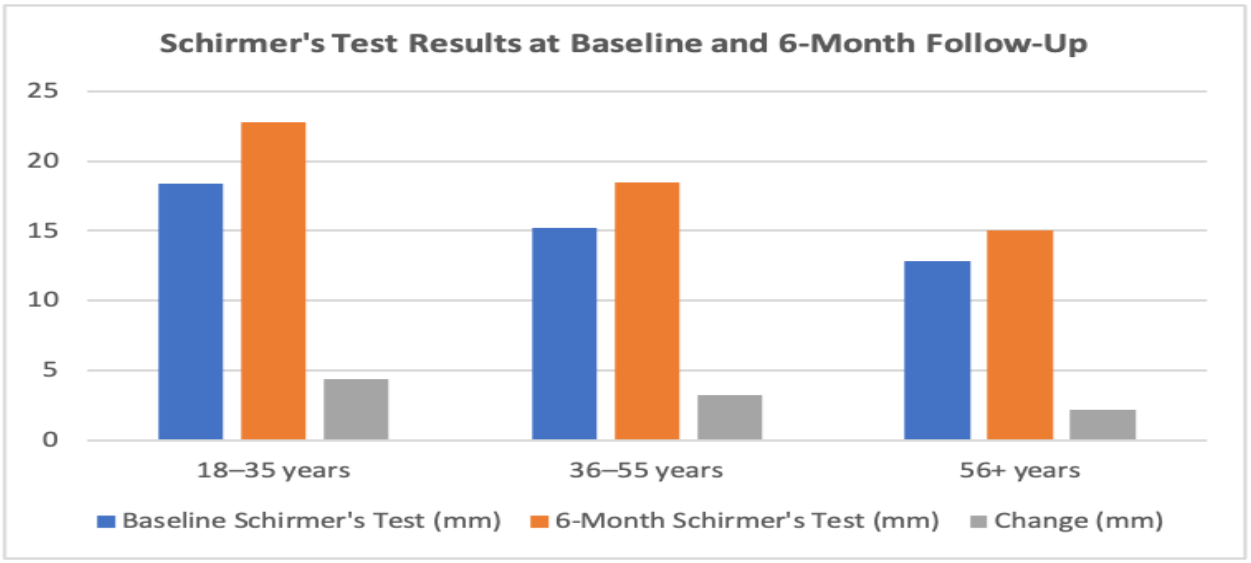

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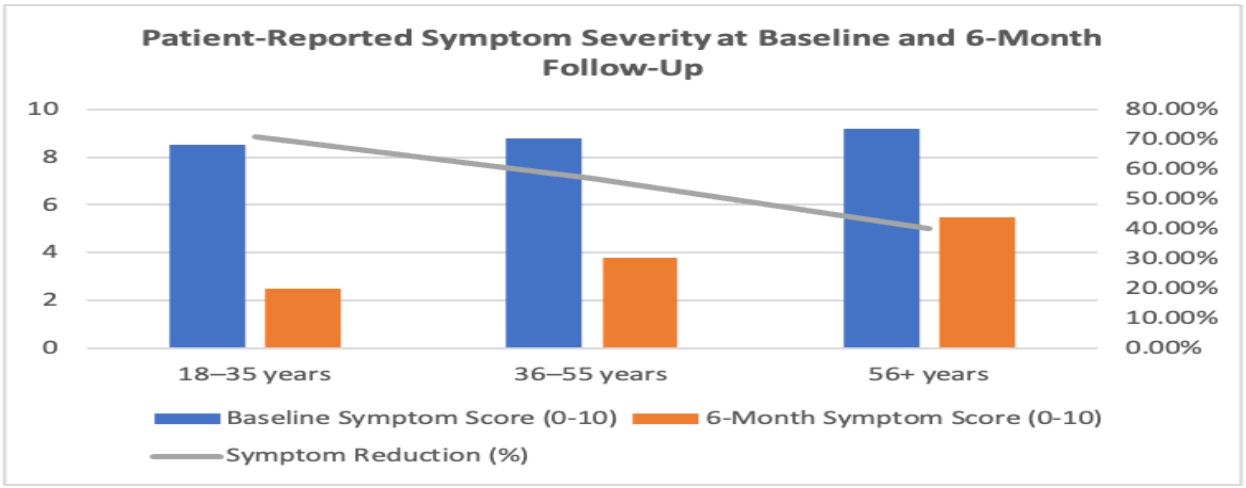

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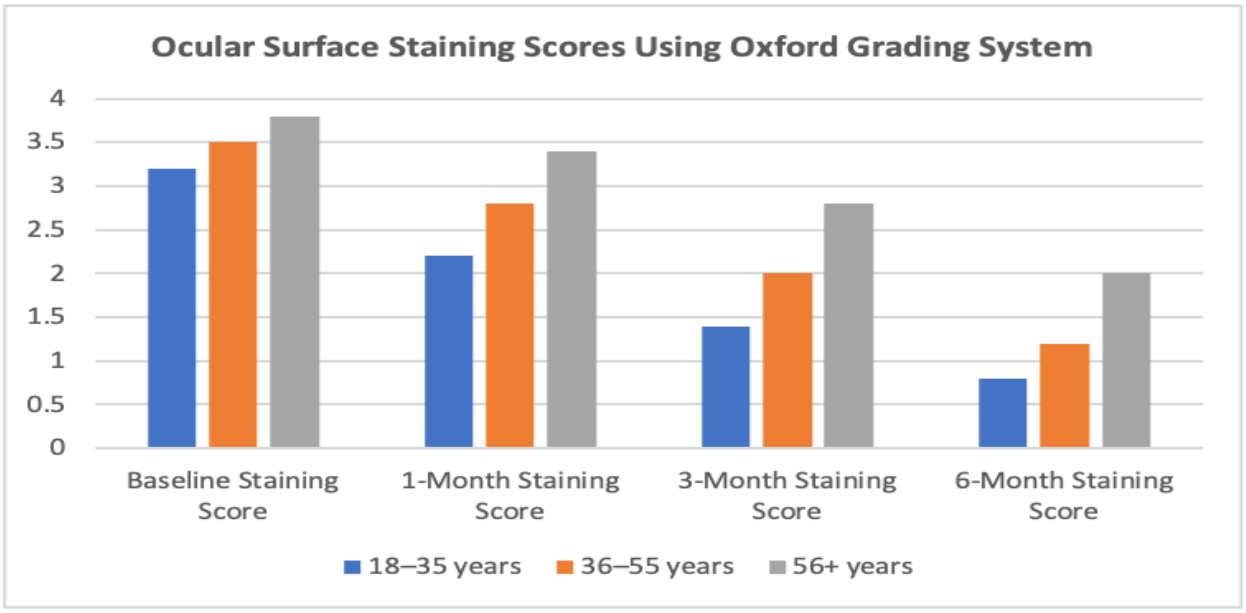

Figure 5:

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Discussion

The results of this study provide strong evidence of age-dependent variations in the response to topical lubrication in patients with Dry Eye Disease (DED). The results shown here confirm that a patient age 18-35-years old attains quicker and almost superior gains in TBUT, Schirmer's test, and OSC compared to older patients. Conversely, the TBUT in elderly patients (56 years old and above) prolonged from 4.9 to 6.8 sec during the 6 months treatment as against the 6.2 to 9.5 sec shown by the 18 to 35 years patients. These results draw attention to changes with age and their implications in the effectiveness of managing DED (13 (14).

These differences might be explained by changes in meibomian gland function that occur as aging influences the tear-film composition. It was also understood that the meibomian glands are involved in the production of the lipid layer of the tear film which prevents tear evaporation. Some researchers have pointed out that the meibomian glands' number and function reduces as people age, and this phenomenon is referred to as meibomian gland dysfunction. MGD is more common in elderly over the age of 55 years and contributes to evaporative dry eye (15) (16).

Another reason for age related differences in the response to treatment is fluctuations in hormone levels. This is because postmenopausal woman is characterized with low estrogen and the reduction in estrogen production affects the production of the aqueous layer of the tear film. Androgens are also involved in regulation of the function of the lacrimal and Meibomian glands, and decrease in androgen levels was reported to result in decreased tear secretion in both sexes. As a result, postmenopausal women are more susceptible to severe DED and have a slower rate of remittance when using artificial tears (17)(18).

Cellular alterations occurring within the ocular surface might also account for the changes with age noted in the present study. These are reductions in the proliferative capacity of corneal epithelial cells, the rate at which the corneal epithelial layer can heal, and stem cell function. There is a decline in ability of Ocular surface to repair in elderly patients due to the increase in oxidative stress, increased reactive oxygen species (ROS) and reduced ability of aging corneal epithelial cells to stabilize tear film. This may explain why, in this study, older patients showed lesser improvement to the ocular staining scores when compared to young patients (19) (20).

Another operational research question finding was the variation of the symptoms in the different age groups. In younger patients this figure reached 70.6% while in patients 56 years and over it comprised only 40.2%. This could be attributed by the differences in neural sensitivity as well as the time variability of the symptoms. The elders are likely to have more chronic inflammation and might get central sensitization meaning that symptom control is going to be harder (21)(22). Consequently, the results of this study support the development of standardized treatment regimens for DED that are particularly relevant for individuals of a specific age. In patients under the age of 40 years, basic Osmolshire(R) (aqueous-based artificial tears) can provide a quick improvement. However, for older adults, and especially for those with MGD or chronic inflammation, further treatment strategies may be needed.

Conclusion

The findings reveal that younger patients (18–35 years) experience significantly better outcomes compared to older age groups. Patients aged 56 and above exhibited slower improvements in Tear Break-Up Time (TBUT), Schirmer's test results, and symptom reduction, which may be attributed to age-related changes in meibomian gland function, reduced ocular surface repair capacity, and decline in tear production. The study also underscores the importance of age-specific treatment protocols, as older patients may require longer treatment durations or additional therapeutic support to achieve optimal outcomes.

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate
Approved by the department Concerned. (IRBEC-TCHMM-02/23)

Consent for publication
Approved

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Conflict of interest

The authors declared absence of conflict of interest.

Author Contribution

ABDUL HALEEM MIRANI (Associate Professor)
Coordination of collaborative efforts.
Study Design, Review of Literature.
SANOBER MEMON (senior registrar)
Conception of Study, Development of Research Methodology Design, Study Design, Review of manuscript, final approval of manuscript.
Conception of Study, Final approval of manuscript.
MUHAMMAD NAEEM (Assistant Professor)
Manuscript revisions, critical input.
Coordination of collaborative efforts.
AFSHEEN SIDDIQI (Assistant Professor)
Data acquisition, analysis.
Manuscript drafting.
RAZWAN ASHRAF (M.D Health Punjab)
Data entry and Data analysis, drafting article.
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Data acquisition, analysis.
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MAHA MAHMOUD ABDUL-LATIF
Study Design, Review of Literature
Manuscript revisions, critical input.
FAHMIDA KHATOON (Professor)
Data acquisition, analysis.
Coordination of collaborative efforts.

Data entry and Data analysis, drafting article.

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