RESEARCH PAPER

Comparative Assessment of Tear Break-Up Time, Schirmer Test Values, and Oxidative Stress Biomarkers among Different Types of Soft Contact Lens Users

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ABSTRACT

Background

Soft contact lenses are widely used for vision correction and cosmetic purposes. Their long-term use may affect tear film stability affecting the ocular surface health. Oxidative stress may act as a possible mechanism behind contact lens-related dry eye symptoms.

Objective

To compare Tear Break-Up Time (TBUT), Schirmer test values, and oxidative stress biomarkers among different types of soft contact lens users and healthy controls.

Methods

This comparative cross-sectional study was conducted at LRBT Tertiary Teaching Eye Hospital, Karachi, Pakistan, during July to December 2025. A total of 150 participants were enrolled through consecutive sampling. The participants were divided into daily disposable lens users (n=50), monthly replacement lens users (n=50), and healthy controls (n=50). TBUT, Schirmer I test, and tear oxidative stress biomarkers were measured and compared among groups.

Results

Significant differences were observed among the study groups. Mean TBUT was 10.2±2.1 seconds in daily disposable users, 8.1±1.9 seconds in monthly replacement users, and 13.4±2.3 seconds in controls ($p<0.001$). Mean Schirmer values were 15.3±3.1 mm, 12.8±2.7 mm, and 19.6±3.4 mm, respectively ($p<0.001$). MDA levels were highest in monthly replacement users (4.82±0.91 nmol/mL) and lowest in controls (2.41±0.63 nmol/mL) ($p<0.001$). SOD and TAC levels were significantly lower among contact lens users ($p<0.001$). MDA showed a significant negative correlation with TBUT and Schirmer values.

Conclusion

Soft contact lens wear is associated with reduced tear film stability, decreased tear secretion, and increased oxidative stress. Monthly replacement lenses showed greater adverse effects than daily disposable lenses.

Keywords: Soft Contact Lens, Tear Break-Up Time, Schirmer Test, Oxidative Stress, Malondialdehyde.

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INTRODUCTION

Soft contact lenses are among the most commonly used methods for vision correction worldwide. They provide good visual quality and cosmetic benefits [1]. But their use may affect the normal tear film. Many users complain of dryness, irritation, foreign body sensation and discomfort, especially after prolonged wear. These symptoms are among the leading causes of contact lens discontinuation [2].

The tear film plays an important role in maintaining corneal health and optical quality. It provides lubrication, nutrition and protection to the ocular surface. Tear film stability is commonly assessed by Tear Break-Up Time (TBUT), while tear production is measured using the Schirmer test [3]. Both tests are widely used in clinical practice for the assessment of dry eye disease. Reduced TBUT and Schirmer values indicate tear film dysfunction and ocular surface compromise [4].

In recent years, oxidative stress has gained attention as an important factor in ocular surface disorders. Oxidative stress occurs when reactive oxygen species exceed the antioxidant defense capacity of tissues [5]. This imbalance can damage lipids, proteins and cellular structures. Malondialdehyde (MDA) is a well-known marker of oxidative damage, whereas superoxide dismutase (SOD) and total antioxidant capacity (TAC) reflect antioxidant defense [6].

Research has shown that oxidative stress contributes to tear film instability, lacrimal gland dysfunction and dry eye disease. Elevated MDA levels and reduced antioxidant activity have been reported in several ocular surface disorders [7].

Although tear film abnormalities in contact lens users have been investigated previously, limited local data are available regarding the relationship between contact lens wear and tear oxidative stress biomarkers. Furthermore, few studies have compared daily disposable and monthly replacement soft lenses in the same population. Therefore, this study was conducted to compare TBUT, Schirmer test values, and oxidative stress biomarkers among different types of soft contact lens users attending a tertiary eye care hospital in Lahore, Pakistan.

METHODOLOGY

This comparative cross-sectional study was conducted at Layton Rahmatulla Benevolent Trust (LRBT) Tertiary Teaching Eye Hospital, Karachi, Pakistan, over a period of six months from July 2025 to December 2025. The study was carried out in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [8]. Ethical approval was obtained from the Institutional Review Board of LRBT Tertiary Teaching Eye Hospital, Lahore (Ref No. LRBT/IRB/2025/07-118). Written informed consent was obtained from all participants before enrollment.

A total sample of 150 participants was included. The sample size was calculated using OpenEpi version 3.01 by considering a 95% confidence level, 80% study power, and an expected moderate effect size in tear film parameters among different soft contact lens users. Participants were recruited through non-probability consecutive sampling and were divided into three groups: daily disposable soft contact lens users, monthly replacement soft contact lens users, and age-matched healthy non-contact lens users, with 50 participants in each group.

Individuals aged 18 to 40 years who had been using soft contact lenses for at least six months were included. Participants with active ocular infection, previous ocular surgery, glaucoma, systemic autoimmune disease, diabetes mellitus, pregnancy, smoking history, use of topical ocular medications, or any diagnosed dry eye disease before contact lens use were excluded to reduce confounding.

Demographic information and contact lens history were recorded using a structured proforma. Tear Break-Up Time (TBUT) was measured after fluorescein instillation, and the average of three readings was recorded in seconds. Schirmer, I test without anesthesia was performed using standard filter paper strips, and wetting length was recorded in millimeters after five minutes. Tear samples were collected from the lower tear meniscus using sterile microcapillary tubes. Oxidative stress biomarkers including malondialdehyde (MDA), superoxide dismutase (SOD), and total antioxidant capacity (TAC) were measured using commercially available colorimetric laboratory assays. Data completeness was checked at the time of collection.

Data were entered and analyzed using SPSS version 26. Quantitative variables were presented as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. Normality was assessed using the Shapiro-Wilk test. Differences among study groups were evaluated using one-way ANOVA with Tukey post-hoc analysis for normally distributed variables or Kruskal-Wallis test for non-normal data. Chi-square test was used for categorical variables. Pearson or Spearman correlation analysis was performed to assess the relationship between tear film parameters and oxidative stress biomarkers. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 150 participants were included in the final analysis, comprising 50 daily disposable soft contact lens users, 50 monthly replacement soft contact lens users, and 50 healthy non-contact lens users. The mean age of the study population was comparable among the groups (p=0.691). There was also no significant difference in gender distribution (p=0.832). Monthly replacement lens users had a significantly longer duration of lens wear and daily wearing time compared to daily disposable lens users (p<0.001) (Table 1).

Table 1. Baseline demographic and clinical characteristics of study participants

Variables	Daily Disposable (n=50)	Monthly Replacement (n=50)	Controls (n=50)	Test Statistic	p-value
Age (years), Mean ± SD	25.8 ± 4.7	26.4 ± 5.1	25.2 ± 4.9	F=0.37	0.691
Male Gender, n (%)	21 (42.0)	23 (46.0)	22 (44.0)	χ^2=0.37	0.832
Duration of Lens Use (years), Mean ± SD	1.8 ± 0.9	3.2 ± 1.4	—	t=6.02	<0.001

Daily Wearing Time (hours/day), Mean ± SD	7.1 ± 1.8	9.0 ± 2.1	—	t=4.89	<0.001
Screen Exposure (hours/day), Mean ± SD	5.4 ± 1.7	5.8 ± 1.9	5.2 ± 1.6	F=1.48	0.231

Data are presented as mean ± SD or frequency (%). ANOVA was used for continuous variables and Chi-square test for categorical variables.

The comparison of tear film parameters showed significant differences among the three groups. Mean TBUT was highest in controls (13.4 ± 2.3 seconds) and lowest in monthly replacement lens users (8.1 ± 1.9 seconds). Similarly, Schirmer test values were significantly reduced among contact lens users, particularly in monthly replacement lens users (p<0.001) (Table 2).

Table 2. Comparison of Tear Break-Up Time and Schirmer Test Values among study groups

Variables	Daily Disposable (n=50)	Monthly Replacement (n=50)	Controls (n=50)	ANOVA (F)	p-value
TBUT (seconds), Mean ± SD	10.2 ± 2.1	8.1 ± 1.9	13.4 ± 2.3	76.54	<0.001
Schirmer Test (mm/5 min), Mean ± SD	15.3 ± 3.1	12.8 ± 2.7	19.6 ± 3.4	58.91	<0.001

TBUT = Tear Break-Up Time. Values are expressed as mean ± SD. One-way ANOVA followed by Tukey post-hoc analysis was applied.

Analysis of oxidative stress biomarkers demonstrated significantly higher tear MDA levels among contact lens users compared with controls. The highest MDA concentration was observed in monthly replacement lens users (4.82 ± 0.91 nmol/mL). Conversely, antioxidant markers including SOD and TAC were significantly lower in contact lens users (Table 3).

Table 3. Comparison of Oxidative Stress Biomarkers among Study Groups

Biomarker	Daily Disposable (n=50)	Monthly Replacement (n=50)	Controls (n=50)	ANOVA (F)	p-value
MDA (nmol/mL), Mean ± SD	3.74 ± 0.82	4.82 ± 0.91	2.41 ± 0.63	98.33	<0.001
SOD (U/mL), Mean ± SD	10.8 ± 2.4	8.9 ± 2.0	14.7 ± 2.8	67.42	<0.001
TAC (mmol/L), Mean ± SD	0.89 ± 0.16	0.73 ± 0.15	1.18 ± 0.19	84.71	<0.001

MDA = Malondialdehyde; SOD = Superoxide Dismutase; TAC = Total Antioxidant Capacity. Values are presented as mean ± SD.

Correlation analysis that oxidative stress biomarkers were significantly associated with tear film dysfunction. MDA showed a moderate negative correlation with both TBUT (r = −0.621, p<0.001) and Schirmer test values (r = −0.543, p<0.001). In contrast, SOD and TAC demonstrated significant positive correlations with TBUT and Schirmer test values (Table 4).

Table 4. Correlation of Oxidative Stress Biomarkers with Tear Film Parameters

Variables	TBUT (r)	p-value	Schirmer Test (r)	p-value
MDA	-0.621	<0.001	-0.543	<0.001
SOD	0.481	<0.001	0.427	<0.001
TAC	0.557	<0.001	0.491	<0.001

Pearson correlation coefficient (r) was used. Negative values indicate inverse association, whereas positive values indicate direct association.

DISCUSSION

Soft contact lens use is common among young adults. It improves vision and cosmetic comfort, but it may disturb the ocular surface if used for long hours. In the present study, monthly replacement lens users showed lower TBUT and Schirmer values as compared to daily disposable lens users and controls. They also showed higher MDA and lower SOD and TAC levels. These findings show that soft contact

lens wear is linked with tear film disturbance and oxidative stress.

TBUT is an important test for tear film stability. In our study, TBUT was lowest in monthly replacement lens users. This finding is in line with previous studies which reported that soft contact lenses reduce tear film breakup time [9]. A contact lens divides the normal tear film into pre-lens and post-lens layers. This makes the tear film thin and less stable [10]. Long wearing time also increases evaporation from the lens surface. This may explain why monthly lens users had more reduction in TBUT than daily disposable users [11].

Schirmer test values were also reduced in contact lens users. This shows that tear secretion was affected. The reduction was more marked in monthly replacement lens users. Repeated lens use, lens deposits, solution exposure and mechanical rubbing during blinking may irritate the ocular surface. This can disturb lacrimal gland reflex and tear production [12]. Daily disposable lenses are replaced every day, so there is less deposit formation. This may be the reason for better Schirmer values in daily disposable users [13].

Oxidative stress markers also supported the clinical findings. MDA was higher in both contact lens groups, especially in monthly replacement lens users. MDA is a marker of lipid peroxidation and tissue stress [14]. Previous studies on dry eye disease have also reported increased MDA in tears and ocular surface samples [15]. In our study, low SOD and TAC levels showed reduced antioxidant defense. This means that the ocular surface was under more oxidative load in lens users. Contact lens-related dryness, friction and tear evaporation can increase reactive oxygen species [16]. These changes may damage tear film lipids and ocular surface cells [17].

The correlation analysis further strengthens these findings. MDA showed negative correlation with TBUT and Schirmer test values. This means that higher oxidative stress was linked with poorer tear stability and lower tear secretion. On the other hand, SOD and TAC showed positive correlation with both tear tests. This suggests that better antioxidant status may protect the tear film. These findings are logical because oxidative stress and tear film dysfunction can support each other. Tear instability increases surface stress, and oxidative injury further worsens tear quality [18].

CONCLUSION

Soft contact lens use was associated with reduced TBUT, lower Schirmer test values and increased tear oxidative stress. Monthly replacement lenses showed greater adverse changes than daily disposable lenses. Early detection and proper counselling can help to prevent contact lens-related dry eye and ocular surface damage.

REFERENCES

1. Rohit, A., *Effect of tear film lipid parameters in contact lens wear comfort*. 2015, UNSW Sydney.
2. Buch, J., et al., *Tear film dynamics of a new soft contact lens.* Ophthalmic and Physiological Optics, 2023. 43(5): p. 1070-1078.
3. Downie, L.E. and J.P. Craig, *Tear film evaluation and management in soft contact lens wear: a systematic approach.* Clinical and Experimental Optometry, 2017. 100(5): p. 438-458.
4. Dammak, A., et al., *Oxidative stress in the anterior ocular diseases: diagnostic and treatment.* Biomedicines, 2023. 11(2): p. 292.
5. Durán-Prieto, E., J.L. Alonso, and J. Carballo-Álvarez, *Contact lens fitting and tear film affectation through thermal camera assessment.* Programa de Doctorado en Óptica, Optometría y Visión Facultad de Óptica y Optometría, 2021: p. 28.
6. Niazi, S., et al., *The microenvironment of ocular surface in keratoconus: a systematic review.* Eye and Vision, 2025. 12(1): p. 37.
7. Kokke, K.H., J.A. Morris, and J.G. Lawrenson, *Oral omega-6 essential fatty acid treatment in contact lens associated dry eye.* Contact Lens and Anterior Eye, 2008. 31(3): p. 141-146.
8. Von Elm, E., et al., *The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies.* The lancet, 2007. 370(9596): p. 1453-1457.
9. Smith, S.L., et al., *An investigation into disposal and recycling options for daily disposable and monthly replacement soft contact lens modalities.* Contact Lens and Anterior Eye, 2022. 45(2): p. 101435.
10. Morgan, P.B., et al., *International trends in daily disposable contact lens prescribing (2000–2023): An update.* Contact Lens and Anterior Eye, 2024. 47(6): p. 102259.
11. 11. Mingo-Botín, D., et al., *Characteristics, behaviors, and awareness of contact lens wearers purchasing lenses over the internet.* Eye & Contact Lens, 2020. 46(4): p. 208-213.
12. McMonnies, C.W., *Eye rubbing type and prevalence including contact lens 'removal-relief'rubbing.* Clinical and Experimental Optometry, 2016. 99(4): p. 366-372.
13. McMonnies, C.W., *Incomplete blinking: exposure keratopathy, lid wiper epitheliopathy, dry eye, refractive surgery, and dry contact lenses.* Contact Lens and Anterior Eye, 2007. 30(1): p. 37-51.
14. Kwong-Han, K., et al., *Comparison of catalase, glutathione peroxidase and malondialdehyde levels in tears among diabetic patients with and without diabetic retinopathy.* Journal of

Diabetes & Metabolic Disorders, 2022. 21(1): p. 681-688.

15. Donma, O., et al., *Blood and lens lipid peroxidation and antioxidant status in normal individuals, senile and diabetic cataractous patients.* Current eye research, 2002. 25(1): p. 9-16.
16. Ahmad, A. and H. Ahsan, *Biomarkers of inflammation and oxidative stress in ophthalmic disorders.* Journal of Immunoassay and Immunochemistry, 2020. 41(3): p. 257-271.
17. Daruich, A., et al., *Levels of the oxidative stress biomarker malondialdehyde in tears of patients with central serous chorioretinopathy relate to disease activity.* Molecular vision, 2020. 26: p. 722.
18. Tang, T., J. Yang, and H. Yin, *Oxidative Stress in Dry Eye Disease: Molecular Mechanisms and Emerging Therapeutic Strategies.* Biomolecules, 2026. 16(5): p. 718.