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Original Article

Effect of Long-Term Soft Contact Lens Wear on Corneal and RNFL Parameters Assessed by Optical Coherence Tomography

Asad Ullah[1], Eisha Fiaz[2], Mariam Sana Ullah[3], Amber Saeed[4], Muhammad Ishfaq[5], Sana Sharif[6], Aqsa Batool[7]

[1] Timergara Teaching Hospital, Timergara, Pakistan
[2] Clinical Optometrist, Department of Optometry, The University of Faisalabad, Faisalabad, Pakistan
[3] Course Coordinator/Senior Lecturer, Munawar Memorial Hospital and College of Optometry, Chakwal, Pakistan
[4] Optometrist/Masters by Research Scholar, University of Gloucestershire, The Park, Cheltenham, Gloucestershire, GL50 2RH, United Kingdom
[5] Optometrist, Diagnostic Department, Sahiwal Eye Care, Farid Town Sahiwal, Pakistan
[6] Optometrist, Khyber Medical University, Peshawar, Pakistan
[7] Optometrist, Department of Ophthalmology, South City Hospital, Karachi, Pakistan

***Corresponding author: Amber Saeed, amberopto609@gmail.com**

ABSTRACT

Background: Long-term soft contact lens wear is associated with ocular surface alterations and corneal changes; however, its relationship with posterior segment parameters, particularly retinal nerve fiber layer (RNFL) thickness measured by optical coherence tomography, remains insufficiently understood. Objective: To evaluate the impact of long-term soft contact lens wear on ocular surface parameters, central corneal thickness, and OCT-derived RNFL measurements, and to assess potential associations between RNFL thickness and clinical variables. Methods: This comparative cross-sectional study included 200 myopic adults divided into 100 long-term contact lens users and 100 non-wearers. All participants underwent tear break-up time, Schirmer test, and Ocular Surface Disease Index assessment, along with OCT measurement of central corneal thickness and RNFL thickness. Group comparisons were performed using independent t-tests, while Pearson correlation and multiple linear regression analyses assessed associations. Results: Contact lens users demonstrated significantly reduced tear break-up time (7.28 ± 2.18 vs 11.00 ± 2.14 seconds), lower Schirmer scores (13.06 ± 4.12 vs 18.08 ± 5.17 mm), and higher OSDI scores (29.38 ± 10.10 vs 14.40 ± 6.99) (all p < 0.001). Central corneal thickness was also lower (518.11 ± 20.15 vs 536.49 ± 17.77 µm, p < 0.001). Average RNFL thickness was reduced in contact lens users (95.85 ± 7.85 vs 100.01 ± 8.18 µm, p < 0.001), with similar reductions across all quadrants. No significant correlations were observed between RNFL thickness and duration of lens wear or ocular surface parameters. Conclusion: Long-term soft contact lens wear is associated with significant ocular surface compromise and corneal thinning, alongside modest reductions in OCT-derived RNFL measurements that are not explained by exposure duration or surface parameters, suggesting potential influence of confounding factors. Keywords: Contact lenses; Optical coherence tomography; RNFL thickness; Corneal thickness; Dry eye; Ocular surface.

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INTRODUCTION

Soft contact lenses remain one of the most commonly prescribed options for the correction of refractive error because they provide good visual performance, convenience, and cosmetic acceptability. Despite these advantages, prolonged lens wear can disturb the ocular surface microenvironment through chronic mechanical interaction with the lid margin, corneal epithelium, and tear film, thereby predisposing habitual wearers to tear film instability, ocular discomfort, and contact lens-related surface complications (1,2). Previous clinical and experimental work has consistently shown that soft lens wear is associated with reduced tear break-up time, altered tear kinetics, increased evaporative stress, and more frequent dry eye-related symptoms when compared with non-wearers (3-7). These changes are clinically relevant because sustained tear film instability may impair surface lubrication, compromise epithelial homeostasis, and reduce overall tolerance to lens wear over time (3-7).

In addition to its effect on the tear film, long-term soft contact lens wear has been linked to subtle anterior segment changes, particularly involving the cornea. Chronic exposure to lens-induced mechanical forces, altered oxygen transmissibility, and local metabolic stress may influence corneal thickness, curvature, epithelial architecture, and surface regularity (8-10). Optical coherence tomography has become an important tool for assessing such changes because it provides high-resolution, noninvasive imaging of both corneal and retinal structures and allows quantitative evaluation of clinically small but potentially meaningful structural differences (11). For this reason, OCT-based analysis offers a useful platform for studying whether habitual lens wear is associated not only with ocular surface disturbance but also with measurable changes in corneal morphology.

The possible relationship between soft contact lens wear and posterior segment OCT parameters remains much less clearly defined. Retinal nerve fiber layer thickness is widely used as an imaging biomarker of retinal ganglion cell axonal integrity and has substantial clinical relevance in glaucoma evaluation and other optic neuropathies. However, RNFL measurements are also influenced by optical, biometric, and acquisition-related factors, making interpretation particularly important in young myopic populations in whom contact lens wear is common. Existing evidence in this area is limited, but one clinical study reported lower RNFL measurements in soft contact lens wearers than in non-wearers, raising the possibility that habitual lens wear may affect OCT-derived RNFL values either through true structural differences, optical measurement effects, or indirect changes related to the anterior segment and refractive status (12). This unresolved issue has practical significance because misinterpretation of RNFL values in contact lens users could complicate clinical decision-making, especially when OCT is used for baseline documentation or glaucoma screening.

Although previous studies have separately examined dry eye parameters, tear film abnormalities, corneal thickness, and isolated OCT findings in contact lens users, there remains a lack of integrated comparative evidence evaluating ocular surface status, corneal structure, and RNFL measurements within the same well-defined study population. The current evidence base is therefore insufficient to determine whether reduced RNFL measurements observed in habitual soft contact lens wearers coexist with ocular surface compromise and corneal thinning, and whether any such RNFL variation is related to the duration of lens wear or to ocular surface disturbance itself. Addressing this gap is important for improving the clinical interpretation of OCT findings in routine optometric and ophthalmic practice.

In this context, the present study was designed to compare ocular surface parameters, central corneal thickness, and OCT-derived RNFL measurements between long-term soft contact lens wearers and age- and sex-comparable non-wearers in a myopic adult population, and to examine whether RNFL thickness is associated with contact lens wear duration and ocular surface indices. We hypothesized that long-term soft contact lens wear would be associated with poorer ocular surface status, thinner corneas, and lower RNFL measurements on OCT relative to controls (1-12).

MATERIALS AND METHODS

This comparative cross-sectional observational study was conducted at the Optometry Clinic of Shifa Eye Care Clinic, Katlang Mardan, Pakistan, over a one-year period from February 2025 to January 2026. The study was designed to evaluate whether long-term soft contact lens wear was associated with differences in ocular surface parameters, central corneal thickness, and retinal nerve fiber layer thickness when compared with individuals with no prior contact lens exposure. A clinic-based comparative design was selected because it allowed standardized assessment of both exposure groups within the same clinical environment and under the same examination protocol.

The study population comprised myopic adults aged 18 to 40 years with best-corrected visual acuity of 6/9 or better. Participants were recruited consecutively from clinic attendees and allocated into two groups according to exposure status. The exposed group included habitual soft contact lens users with a history of lens wear for at least one year and an average daily wear time of at least six hours. The comparison group included age- and sex-comparable individuals with no previous history of contact lens use. Participants were excluded if they had a history of ocular surgery, including refractive procedures such as LASIK, PRK, or SMILE, or if they had glaucoma, keratoconus, retinal pathology, diabetes mellitus, hypertension, astigmatism greater than 2.00 diopters, or poor-quality OCT scans. To avoid inter-eye correlation and preserve statistical independence, only one eye per participant was included in the final analysis, with the right eye selected preferentially unless contraindicated.

The minimum required sample size was calculated for a two-group comparison using an expected mean difference of 5 μm in RNFL thickness, a standard deviation of 8 μm, a two-sided alpha of 0.05, and 80% power, which yielded an estimated requirement of approximately 90 participants per group. To improve statistical precision and allow for unusable or poor-quality scans, the final target sample was increased to 100 participants per group, giving a total sample of 200 participants (13). Recruitment continued until both study groups reached the predetermined sample size.

After eligibility screening, all participants provided written informed consent before enrollment. A standardized clinical history was obtained that included age, sex, refractive status, and, for contact lens users, duration of wear, average daily wearing time, lens material, and replacement schedule. Participants in the contact lens group were instructed to discontinue lens wear for at least 24 hours before imaging in order to reduce transient corneal changes related to recent lens use. All examinations were conducted in a standardized sequence and at a consistent time of day to minimize diurnal variation in tear film and corneal measurements.

Each participant underwent a comprehensive ophthalmic evaluation including visual acuity assessment, objective and subjective refraction, and slit-lamp biomicroscopy of the anterior segment. Ocular surface status was assessed using tear break-up time, Schirmer testing, and the Ocular Surface Disease Index questionnaire. Tear break-up time was recorded in seconds as an indicator of tear film stability, Schirmer test values were recorded in millimeters as a measure of tear production, and OSDI score was used as a standardized measure of dry eye symptom burden. The principal structural corneal outcome was central corneal thickness, measured in micrometers. Posterior segment assessment focused on OCT-derived retinal nerve fiber layer thickness, including average RNFL thickness and quadrant-wise values for the superior, inferior, nasal, and temporal sectors.

All OCT examinations were performed by a single experienced operator using the same instrument and a uniform scanning protocol throughout the study period in order to minimize inter-observer and procedural variability. Both anterior and posterior segment scans were obtained under standardized acquisition conditions, and only scans with acceptable signal quality and without motion artifacts were retained for analysis. The use of the same device, same operator, fixed examination order, and prespecified scan quality criteria was intended to improve reproducibility and reduce measurement bias. Data collection sheets were reviewed on the day of examination for completeness and internal consistency before entry into the study database.

The primary comparative outcomes were central corneal thickness and average RNFL thickness. Secondary outcomes included TBUT, Schirmer test score, OSDI score, and quadrant-specific RNFL measurements. The principal exposure variable was long-term soft contact lens wear, operationally defined as soft lens use for at least one year with average daily use of six hours or more. Duration of contact lens wear was recorded in years for correlation and regression analyses. Several design features were incorporated to reduce bias and confounding, including restriction of the sample to myopic adults within a narrow age range, exclusion of participants with ocular or systemic conditions known to affect corneal or retinal structure, inclusion of only one eye per participant, recruitment of an age- and sex-comparable control group, and multivariable modeling of selected clinical covariates when evaluating predictors of RNFL thickness.

All data were entered and analyzed using SPSS version 26. Quantitative variables were summarized as mean and standard deviation, whereas categorical variables were presented as frequencies and percentages. Distributional assumptions were evaluated before inferential testing. Between-group comparisons of continuous variables were performed using the independent-samples t test. Pearson correlation analysis was used within the contact lens group to examine the relationship between duration of lens wear and selected ocular parameters. Multiple linear regression analysis was then performed to assess potential predictors of average RNFL thickness among contact lens users, with age, duration of contact lens wear, TBUT, and OSDI score entered as independent variables. Complete-case analysis was used, and scans that did not meet predefined quality requirements were excluded before final statistical modeling. All tests were two-tailed, and a p value of 0.05 or less was considered statistically significant.

The study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was obtained from the relevant institutional review authority before the start of data collection, and written informed consent was obtained from all participants prior to examination. Standardized protocols for recruitment, examination, data recording, scan quality control, and statistical analysis were followed throughout the study to support data integrity, reproducibility, and methodological consistency (13).

RESULTS

The study included 200 participants equally divided between long-term soft contact lens users and controls. As shown in Table 1, the mean age of participants in the contact lens group was 28.66 ± 6.39 years compared to 27.04 ± 6.38 years in the control group, yielding a mean difference of 1.62 years (95% CI: -0.17 to 3.41), which was not statistically significant ($p = 0.076$). The effect size was small (Cohen's d = 0.25), indicating minimal practical difference. Gender distribution was also comparable, with males comprising 46% of the contact lens group and 50% of controls ($p = 0.574$), confirming demographic equivalence between groups.

Table 2 demonstrates significant differences in ocular surface and corneal parameters. Tear break-up time (TBUT) was substantially lower in contact lens users (7.28 ± 2.18 seconds) compared to controls (11.00 ± 2.14 seconds), with a mean difference of -3.72 seconds (95% CI: -4.32 to -3.12, $p < 0.001$) and a large effect size (d = 1.72). Similarly, Schirmer test values were reduced by -5.02 mm in the contact lens group (13.06 ± 4.12 mm vs 18.08 ± 5.17 mm; 95% CI: -6.28 to -3.76, $p < 0.001$), corresponding to a large effect size (d = 1.08). In contrast, OSDI scores were markedly elevated among contact lens users (29.38 ± 10.10) compared to controls (14.40 ± 6.99), with a mean increase of 14.98 points (95% CI: 12.50 to 17.46, $p < 0.001$) and a large effect size (d = 1.72).

Central corneal thickness (CCT) was also significantly reduced in the contact lens group (518.11 ± 20.15 µm vs 536.49 ± 17.77 µm), with a mean difference of -18.38 µm (95% CI: -23.70 to -13.06, $p < 0.001$) and a large-to-moderate effect size (d = 0.98). Collectively, these findings indicate clinically meaningful deterioration in tear film stability, tear production, symptom burden, and corneal thickness among long-term contact lens users.

As presented in Table 3, retinal nerve fiber layer thickness was consistently lower in the contact lens group across all parameters. The average RNFL thickness was reduced by -4.16 µm (95.85 ± 7.85 µm vs 100.01 ± 8.18 µm; 95% CI: -6.38 to -1.94, $p < 0.001$), with a moderate effect size (d = 0.52). Quadrant-wise analysis revealed similar reductions: superior RNFL was lower by -4.66 µm (95% CI: -7.06 to -2.26, $p < 0.001$, d = 0.54), inferior RNFL by -4.71 µm (95% CI: -7.16 to -2.26, $p < 0.001$, d = 0.53), nasal RNFL by -4.17 µm (95% CI: -6.42 to -1.92, $p < 0.001$, d = 0.51), and temporal RNFL by -3.62 µm (95% CI: -5.89 to -1.35, $p = 0.002$, d = 0.44). While all differences were statistically significant, the effect sizes were consistently in the small-to-moderate range, indicating modest reductions in OCT-derived RNFL measurements.

Correlation analysis within the contact lens group (Table 4) revealed no statistically significant associations between duration of contact lens wear and any measured parameter. The correlation between duration of lens wear and average RNFL thickness was weakly negative (r = -0.08, 95% CI: -0.27 to 0.12, p = 0.432).

Similarly, no meaningful relationship was observed between duration and TBUT (r = -0.01, p = 0.918) or OSDI score (r = 0.15, p = 0.138). TBUT also showed no significant association with RNFL thickness (r = 0.07, p = 0.487). All correlations were weak and statistically non-significant, suggesting that duration of lens wear and tear film parameters were not linearly related to RNFL measurements in this cohort.

Multiple linear regression analysis (Table 5) further confirmed the absence of significant predictors of RNFL thickness among contact lens users. The overall model was not statistically significant (F = 1.05, p = 0.381) and explained only 4% of the variance in RNFL thickness (R^2 = 0.04; adjusted R^2 = 0.01). Duration of contact lens wear showed a small, non-significant negative association (B = -0.12, 95% CI: -0.42 to 0.18, p = 0.425).

TBUT demonstrated a non-significant positive association (B = 0.18, 95% CI: -0.10 to 0.46, p = 0.203), while OSDI score (B = -0.05, p = 0.273) and age (B = -0.09, p = 0.265) also failed to reach statistical significance. These findings indicate that the observed differences in RNFL thickness between groups cannot be explained by duration of contact lens wear, ocular surface status, or age within this study population.

Table 1. Demographic Characteristics of Study Participants

Variable	CL Users (n=100) Mean ± SD / n (%)	Controls (n=100) Mean ± SD / n (%)	Mean Difference / % Difference	95% CI	p-value	Effect Size (Cohen's d)
Age (years)	28.66 ± 6.39	27.04 ± 6.38	1.62	-0.17 to 3.41	0.076	0.25
Gender (Male)	46 (46%)	50 (50%)	-4%	—	0.574*	—
Gender (Female)	54 (54%)	50 (50%)	+4%	—	—	—

Table 2. Comparison of Ocular Surface and Corneal Parameters

Variable	CL Users (Mean ± SD)	Controls (Mean ± SD)	Mean Difference	95% CI	p-value	Effect Size (Cohen's d)
TBUT (sec)	7.28 ± 2.18	11.00 ± 2.14	-3.72	-4.32 to -3.12	<0.001	1.72
Schirmer (mm)	13.06 ± 4.12	18.08 ± 5.17	-5.02	-6.28 to -3.76	<0.001	1.08
OSDI Score	29.38 ± 10.10	14.40 ± 6.99	+14.98	12.50 to 17.46	<0.001	1.72
CCT (µm)	518.11 ± 20.15	536.49 ± 17.77	-18.38	-23.70 to -13.06	<0.001	0.98

Table 3. Comparison of RNFL Thickness Between Groups

Parameter	CL Users (Mean ± SD)	Controls (Mean ± SD)	Mean Difference	95% CI	p-value	Effect Size (Cohen's d)
RNFL Average (µm)	95.85 ± 7.85	100.01 ± 8.18	-4.16	-6.38 to -1.94	<0.001	0.52
RNFL Superior (µm)	100.67 ± 8.41	105.33 ± 9.09	-4.66	-7.06 to -2.26	<0.001	0.54
RNFL Inferior (µm)	102.04 ± 8.66	106.75 ± 9.22	-4.71	-7.16 to -2.26	<0.001	0.53
RNFL Nasal (µm)	92.91 ± 7.95	97.08 ± 8.29	-4.17	-6.42 to -1.92	<0.001	0.51
RNFL Temporal (µm)	92.12 ± 7.94	95.74 ± 8.40	-3.62	-5.89 to -1.35	0.002	0.44

Table 4. Correlation Analysis Among Contact Lens Users (n=100)

Variable 1	Variable 2	r-value	95% CI	p-value
CL Duration (years)	RNFL Average	-0.08	-0.27 to 0.12	0.432
CL Duration (years)	TBUT	-0.01	-0.20 to 0.19	0.918
CL Duration (years)	OSDI Score	0.15	-0.05 to 0.33	0.138
TBUT	RNFL Average	0.07	-0.13 to 0.26	0.487

Table 5. Multiple Linear Regression Analysis for Predictors of RNFL Thickness (CL Users Only)

Variable	B (Unstandardized)	Standard Error	Standardized β	95% CI	p-value
Constant	98.50	4.20	—	90.16 to 106.84	<0.001
CL Duration (years)	-0.12	0.15	-0.08	-0.42 to 0.18	0.425
TBUT (sec)	0.18	0.14	0.12	-0.10 to 0.46	0.203
OSDI Score	-0.05	0.04	-0.11	-0.13 to 0.03	0.273
Age (years)	-0.09	0.08	-0.10	-0.25 to 0.07	0.265

Overall, the results consistently demonstrate that long-term soft contact lens wear is associated with significant deterioration in ocular surface parameters and reduced corneal thickness, alongside modest but statistically significant reductions in OCT-derived RNFL measurements. However, the absence of significant correlations or predictive relationships suggests that RNFL variation is not directly attributable to duration of lens wear or measured ocular surface factors.

The figure demonstrates a parallel downward shift in both central corneal thickness (CCT) and retinal nerve fiber layer (RNFL) thickness among long-term contact lens users compared to controls, highlighting a consistent structural gradient across anterior and posterior segment parameters. Specifically, mean CCT decreased from 536.49 µm (95% CI: 531.17–541.81) in controls to 518.11 µm

(95% CI: 512.79–523.43) in contact lens users, representing a reduction of 18.38 μm. Similarly, mean RNFL thickness declined from 100.01 μm (95% CI: 97.84–102.18) to 95.85 μm (95% CI: 93.66–98.04), corresponding to a difference of 4.16 μm.

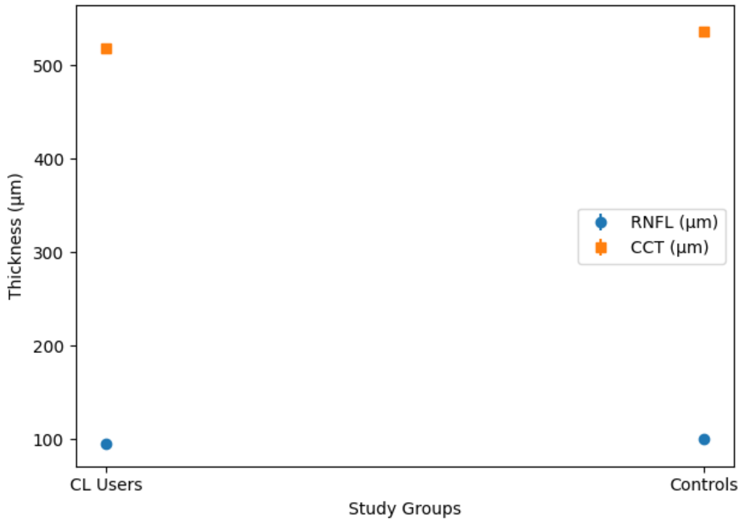

Figure 1 Comparative Gradient Of Corneal And RNFL Thickness Across Contact Lens Exposure

The non-overlapping confidence intervals for both parameters indicate statistically robust differences between groups. Notably, the magnitude of corneal thinning is substantially greater than that observed for RNFL, suggesting a stronger anterior segment susceptibility to long-term contact lens wear. The aligned directional reduction across both measures supports a pattern of global structural alteration, although the relatively smaller RNFL difference, combined with previously reported weak associations and low explanatory variance, suggests that posterior segment changes may be modest and potentially influenced by additional factors beyond contact lens exposure alone.

DISCUSSION

The present study provides a comprehensive comparative evaluation of ocular surface parameters, central corneal thickness, and OCT-derived retinal nerve fiber layer measurements in long-term soft contact lens users versus non-wearers within a myopic adult population. The findings demonstrate that habitual contact lens wear is associated with significantly reduced tear film stability, decreased tear production, increased subjective dry eye symptoms, and reduced central corneal thickness. In addition, modest but statistically significant reductions in RNFL thickness were observed across all quadrants. However, correlation and regression analyses revealed that these RNFL differences were not significantly associated with duration of lens wear or ocular surface parameters, suggesting a more complex and potentially indirect relationship.

The observed reduction in tear break-up time and Schirmer values among contact lens users is consistent with established evidence that contact lenses disrupt the precorneal tear film and alter tear dynamics. The presence of a lens divides the tear film into pre- and post-lens layers, leading to increased evaporation, instability, and reduced tear exchange, which collectively contribute to ocular surface desiccation and discomfort (14-18).

The significantly higher OSDI scores in the contact lens group further support the clinical relevance of these physiological changes, indicating that structural alterations are accompanied by symptomatic burden. These findings reinforce the concept that long-term contact lens wear is a significant contributor to dry eye disease and ocular surface dysfunction in otherwise healthy individuals (19,20).

The reduction in central corneal thickness observed in this study aligns with previous reports suggesting that prolonged contact lens wear can induce subtle corneal changes, potentially mediated by chronic hypoxic stress, altered epithelial turnover, and mechanical interaction between the lens and corneal surface (21-23). Although the magnitude of thinning observed in this study (approximately 18 μm) is statistically significant, its clinical implications require careful interpretation, as corneal thickness may fluctuate with lens type, oxygen permeability, and wearing patterns. Nevertheless, these findings highlight the importance of considering corneal structural changes in long-term contact lens users, particularly when interpreting pachymetry-dependent clinical assessments.

A key contribution of this study is the demonstration of reduced OCT-derived RNFL measurements in contact lens users compared to controls. While the differences were statistically significant, the effect sizes were modest, and the absolute differences (approximately 3–5 μm across parameters) fall within a range that may be influenced by known sources of variability in OCT measurement. Importantly, the lack of significant correlation between RNFL thickness and duration of contact lens wear suggests that cumulative exposure alone does not explain the observed differences. This finding is consistent with prior work indicating that RNFL measurements may be affected by optical and biometric factors rather than reflecting true neurodegenerative changes (12).

One plausible explanation for the observed RNFL differences relates to refractive and anatomical characteristics inherent to myopic populations. Previous studies have demonstrated that increasing axial length and myopic refractive error are associated with thinner RNFL measurements due to retinal stretching and geometric scaling effects (24-26).

Given that the present study population consisted exclusively of myopic individuals and did not incorporate axial length measurements, residual confounding related to refractive status cannot be excluded. In addition, subtle changes in corneal curvature or surface regularity induced by contact lens wear may influence OCT signal quality or segmentation accuracy, thereby contributing to apparent differences in RNFL thickness without reflecting true neural loss.

The absence of significant associations in both correlation and regression analyses further supports the notion that RNFL variation in this cohort is not directly driven by contact lens wear duration or ocular surface status. The regression model explained only a small proportion of the variance in RNFL thickness ($R^2 = 0.04$), indicating that other unmeasured factors are likely responsible for the majority of variability. This reinforces the importance of interpreting OCT-derived RNFL measurements in contact lens users with caution, particularly in clinical contexts such as glaucoma screening where small differences may influence diagnostic decisions.

From a clinical perspective, these findings suggest that while long-term contact lens wear clearly impacts the ocular surface and cornea, its influence on posterior segment measurements is more subtle and potentially confounded. Clinicians should ensure that OCT assessments are performed under standardized conditions, ideally after discontinuation of lens wear, and should consider refractive status and other biometric variables when evaluating RNFL thickness in contact lens users. Establishing individualized baseline measurements may be particularly valuable in this population to avoid misinterpretation of longitudinal changes.

The strengths of this study include the simultaneous assessment of anterior and posterior segment parameters using a standardized OCT protocol, the inclusion of a well-defined comparison group, and the use of multiple analytical approaches to explore associations. However, several limitations should be acknowledged.

The cross-sectional design precludes causal inference, and the absence of axial length and detailed refractive data limits the ability to fully account for confounding factors affecting RNFL measurements. Additionally, while efforts were made to standardize imaging conditions, subtle optical influences related to corneal changes cannot be entirely excluded. Future longitudinal studies incorporating axial length measurements, refractive stratification, and advanced OCT analysis are needed to clarify whether the observed RNFL differences represent true structural variation or measurement-related effects.

CONCLUSION

Long-term soft contact lens wear is associated with significant deterioration in ocular surface parameters, reduced tear film stability, decreased tear production, increased dry eye symptoms, and measurable thinning of the central cornea. In addition, modest reductions in OCT-derived retinal nerve fiber layer thickness were observed; however, these differences were not associated with duration of lens wear or ocular surface indices and are likely influenced by confounding optical and biometric factors rather than representing true neural alteration. These findings underscore the importance of cautious interpretation of OCT measurements in contact lens users and highlight the need for further longitudinal and controlled studies to determine the clinical significance of observed structural variations.

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