

Comparison of Non-Water Proof Mascara Adhesion on the Surface of Different Two-week Frequent Replacement Silicone Hydrogel Contact Lenses

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Purpose: Cosmetic products, such as mascara, are known to adhere to the surface of silicone hydrogel soft contact lenses (SiHySCLs), potentially affecting lens performance and comfort. However, little is known about how different SiHySCL materials influence cosmetic adhesion. Recent reports suggest that the newly introduced lehfilcon A, a 2-week frequent replacement SiHySCL with Water Gradient and Celligent technology, may exhibit reduced lipid and cosmetic adherence. This study aimed to compare the adhesion of non-waterproof mascara to four types of 2-week frequent replacement SiHySCLs to better understand the impact of lens material properties on cosmetic contamination.

Methods: Four variants of SiHySCLs were utilized: samfilcon A, comfilcon A, senofilcon A, and lehfilcon A (with 12 lenses in each category). Non-waterproof mascara was randomly applied in a cross-pattern on the SiHySCL surface using the Latin squares method. Microscopic photography and ImageJ analysis software were employed to assess the proportion of mascara adhering to the SiHySCL surface following a one-hour soak in saline solution.

Results: The observed percentages of remaining mascara adhesion on the SiHySCL surfaces were as follows: samfilcon A ($3.1 \pm 1.7\%$), comfilcon A ($6.0 \pm 1.4\%$), senofilcon A ($7.1 \pm 1.5\%$), and lehfilcon A ($0.9 \pm 0.2\%$). Notably, lehfilcon A exhibited a significantly lower percentage of adhered non-water proof mascara compared to the other lenses ($p < 0.01$).

Conclusion: This study demonstrates that SiHySCL material properties significantly influence mascara adhesion. Among the tested lenses, lehfilcon A showed the lowest level of mascara adherence, suggesting that its Water Gradient and Celligent technology may contribute to reduced cosmetic contamination. These findings provide valuable insights for individuals who wear makeup and use SiHySCLs, as well as for future lens material development.

Plain language summary: Cosmetics, like mascara, can stick to contact lenses, causing discomfort and potentially affecting vision. This study examined how well non-waterproof mascara adheres to four types of silicone hydrogel contact lenses designed for 2-week use. A special lens called lehfilcon A, featuring advanced surface technology, showed the least amount of mascara sticking to it compared to the other lenses tested. The findings suggest that lehfilcon A may be a better choice for people who wear contact lenses and use non-waterproof mascara, as it helps keep the lenses cleaner and clearer.

Keywords: lehfilcon A, non-water proof mascara, silicone hydrogel, reusable silicone hydrogel soft contact lens

Introduction

Contact lenses (CLs) have become a widely adopted method for visual correction. However, a common challenge for CL wearers, particularly women, is the adhesion of cosmetics and mascara onto lenses. This adhesion can lead to visual

disruption and reduced lens comfort.¹ Silicone hydrogel soft contact lenses (SiHySCLs) are most lipophilic than conventional soft contact lenses (SCLs).^{2–5} Consequently, they have an increased propensity to absorb proteins from substances, such as cosmetics. Recent research indicates that contact with cosmetic products, including cleansing oils, makeup removers, and hand creams, can induce alterations in critical parameters, such as lens diameter and base curve (Carney 2008; Tsukiyama 2010; Luensmann 2019).^{4,6,7}

Ensuring comfort while wearing SCLs relies on four key factors. First, the SCL surface must align with the cellular structure of the ocular surface. Second, minimizing physical irritation and friction between SCLs and the ocular surface is crucial. Third, the surfaces of SCLs require high water wettability and content. Finally, safeguarding the lens surface against the adsorption of proteins and lipids is essential. Novel technologies aimed at creating a smoother surface, reducing friction, and minimizing debris adhesion are expected to facilitate the development of an ideal SCL surface structure.

Recently, a novel advancement known as Water Gradient technology has emerged as a groundbreaking approach for the treatment of SCLs surfaces. This innovative technology has achieved a ‘water gradient’ structure by manipulating varying water content within the lens core and surface layers.^{8–13} These SCLs exhibited a lower moisture content at the core, transitioning to nearly 100% at the surface, creating a highly hydrophilic layer. This technology has been applied to delefilcon A and verofilcon A 1-day disposable SiHySCLs.^{11–13}

In recent developments, 2-methacryloyloxyethyl phosphorylcholine (MPC) has emerged as a biomimetic coating material.^{14,15} MPC polymers are synthesized to replicate the structure of the phospholipid polar groups present on living cell membranes. Surfaces treated with MPC polymers have been engineered to mimic cell membrane structures, thereby hindering their interactions with living organisms. MPCs exhibit numerous advantageous properties, including high biocompatibility, imparting surfaces with high lubrication and low friction, deterring protein and cell adhesion, modifying diverse device surfaces to emulate cell membranes, and applicability to various biomaterials.^{14,15} This innovative MPC polymer technology, known as Celligent, has been employed to coat the surface of bio-mimetic lenses such as lehfilcon A.^{16–18}

SCLs with smooth surfaces are expected to resist stains from mascara and other cosmetics. Multiple studies have investigated the adhesion of mascara to SCLs. Early investigations underscored the importance of scrubbing to clean mascara residues in CLs.¹⁹ Hydrogen peroxide-based disinfection has shown efficacy in eliminating deposits such as mascara from SiHySCLs.^{20,21} Furthermore, specific eye makeup removers and waterproof mascaras have been observed to compromise the shape and optical performance of certain SiHySCLs.²² Nevertheless, a comprehensive understanding of the factors responsible for mascara adhesion to CLs, along with the mechanisms and effects of such adhesion, remains incomplete.

This study aimed to evaluate non-waterproof mascara adhesion to various 2-week replacement SiHySCLs and correlate adhesion levels with lens surface properties. Insights gained from this research will guide the development of more comfortable and effective SCL designs and offer recommendations for their use.

Materials and Methods

Research Design

This study was a non-clinical comparative effectiveness investigation. The procedures were approved by the Ethics Committee of Teikyo University (#Teirin 18–227). This research was conducted at the ophthalmology laboratory of Teikyo University School of Medicine from August 2023 to September 2023.

Four types of commercially available two-week frequent replacement SiHySCLs (2WSiHySCLs), each with a prescription of −4.0 diopters and a sample size of $n = 12$ per lens type, were assessed (see Table 1). The evaluated 2WSiHySCLs were as follows samfilcon A (Bausch & Lomb, Inc., Rochester, NY, USA), comfilcon A (CooperVision Inc., Scottsville, NY, USA), senofilcon A (Johnson & Johnson Vision Care, Inc., Jacksonville, FL, USA), and lehfilcon A (Alcon Japan Ltd., Tokyo, Japan). A total of 48 CLs were used in this study.

Non-waterproof mascara was applied to the surface of the SCLs, and subsequent microscopic observations were performed to evaluate the extent of contamination caused by non-waterproof mascara after washing.

Table 1 Characteristics of the Contact Lenses

USAN Nomenclature	Samfilcon A	Comfilcon A	Senofilcon A	Lehfilcon A
Water Content (%)	46	48	38	Core 55 / Surface 100
Oxygen Permeability (Dk)	114	128	103	123
Oxygen Transmissibility (Dk/L)	163	160	147	154
Diameter (mm)	14.2	14.0	14.0	14.2
Base Curve (mm)	8.7	8.6	8.8/8.4	8.7
CT (mm)	0.07	0.08	0.07	0.08
Tint	Blue	Aqua Blue	Blue	Light Green
FDA group	I	I	I	II
Principal Components	mPDMS, NVP, DMA, HEMA	mPDMS, NVP	2-HEMA, SiMAA2, mPDMS 1000, DMA, Methacrylate cross-linking agents	mPDMS, GPDMS, NVP

Abbreviations: USAN, United States adopted names; CT, Center thickness of contact lens; FDA, Food and Drug Administration; mPDMS, monomethacrylate polydimethylsiloxane; NVP, N-vinyl pyrrolidone; DMA, N,N-dimethylacrylamide; HEMA (2-HEMA), 2-Hydroxyethyl methacrylate; SiMAA2, (3-Methacryloxy-2-hydroxypropoxy) propylbis (trimethylsiloxy) methylsilane; mPDMS 1000, mono-methacryloxypropyl terminated polydimethylsiloxane; GPDMS, Glycerol-functionalized polydimethylsiloxane.

To ensure objectivity, all study conductors and evaluators were fully blinded to the type of SCLs used throughout the evaluation process. Strict blinding protocols were implemented, and neither the study implementers nor the evaluators had access to any information that could reveal the type of SCL used. The study design incorporated rigorous blinding procedures to minimize potential bias. Additionally, while this study was sponsored by Alcon Japan Ltd., all experimental procedures, data collection, and analysis were conducted independently, adhering to established scientific and ethical standards.

Adhesion of Non-Waterproof Mascara to SCLs

The process involved extracting SiHySCLs from each study's blister packaging, followed by desalination through an overnight soak in phosphate-buffered saline (PBS). Subsequently, the SiHySCLs were affixed to rounded-end silicone lens holders. For the adhesion study, black non-waterproof mascara (L'Oréal Paris Voluminous, L'Oreal, Clichy, France) was used.

The non-waterproof mascara, as indicated in its package insert, contains the following constituents: water, paraffin, potassium cetyl phosphate, copernicia cerifera cera/carnauba wax, ethylene/acrylic acid copolymer, styrene/acrylates/ammonium methacrylate copolymer, cera alba/beeswax/cire dabeille, synthetic beeswax, bis-diglyceryl polyacyladipate-2, polybutene, cetyl alcohol, steareth-20, glyceryl dibehenate, steareth-2, phenoxyethanol, hydroxyethylcellulose, acacia senegal gum, tribehenin, caprylyl glycol sodium laureth sulfate, silica, tetrasodium ethylenediaminetetraacetic acid (EDTA), ricinus communis seed oil/castor seed oil, maltodextrin, potassium sorbate, butylated hydroxytoluene (BHT), propylene glycol centaurea cyanus flower extract, propyl gallate, and citric acid.

The application of non-waterproof mascara onto the SiHySCLs involved gently rolling the brush across the CL surface and executing a single left-to-right motion solely on the front curve. Subsequently, the lens holder was rotated by approximately 90°, and non-waterproof mascara was reapplied using the same method. Subsequently, the SiHySCLs remained on the holders for an additional 30 seconds to ensure fixation of the non-waterproof mascara adhesion before being transferred to a fresh PBS solution.

The SiHySCLs were immersed in PBS for an hour before evaluation. After this period, the SiHySCLs were rinsed three times with PBS and examined under a microscope for initial observation after washing. Subsequently, the lenses

were placed in PBS and shaken for 3 minutes. After shaking, the samples were rinsed three times with PBS and observed for a second time under a microscope (post-shaking).

Adhered Surface Area Percentage of Non-Waterproof Mascara on SiHySCL Surface

The percentage of the adhered area of non-waterproof mascara on the surface of SiHySCLs was quantified. Microscopic observations and photographs of the front surface of the SCL were performed. The adhered area proportions were determined by analyzing photographic images using ImageJ analysis software (version 1.52a; Wayne Rasband, NIH, Bethesda, MD, USA, <http://imagej.nih.gov/ij/docs/index.html>).

To ensure thoroughness, the evaluation process involved repeated testing with a new lens for each test cycle until the number of tests per lens brand reached 12. The sequence of testing for the four SiHySCLs was randomized according to a table generated using the Latin square design.

Statistical Analyses

Data are expressed as means $\pm$ standard deviation or percentages. The Tukey–Kramer test was used to compare the mean adherent area of non-waterproof mascara on the surface of SiHySCLs between the two groups. One-way analysis of variance (ANOVA) was used to compare the mean values across the four groups. All statistical analyses were conducted using SAS System software version 9.1 (SAS Institute Inc., Cary, NC, USA), and significance was established at $P < 0.05$.

Results

Using the Latin squares method, 12 tests were conducted across the four types of SCLs, dividing them into 12 groups for comparison of means. Post-rinsing ($p=0.999$, between-group variation=14.8) and post-shaking ($p=0.958$, between-group variation=12.2) analyses using one-way ANOVA revealed no significant differences between the 12 groups. This outcome suggests that neither the passage of time nor the sequential steps influenced the results from the initial to the twelfth test. The randomized testing approach confirms that procedures and methodologies employed in this study effectively ensured the precision and accuracy of the experimental outcomes.

Figure 1 shows photographs of the four distinct SCLs following washing and shaking processes. The observed percentages of remaining non-water proof mascara adhesion on the SiHySCL surfaces were as follows: samfilcon A ($3.1 \pm 1.7\%$), comfilcon A ($6.0 \pm 1.4\%$), senofilcon A ($7.1 \pm 1.5\%$), and lehfilcon A ($0.9 \pm 0.2\%$). Notably, lehfilcon A exhibited a significantly lower percentage of adhered non-water proof mascara compared to the other lenses ($p<0.01$, respectively, as shown in Figure 2).

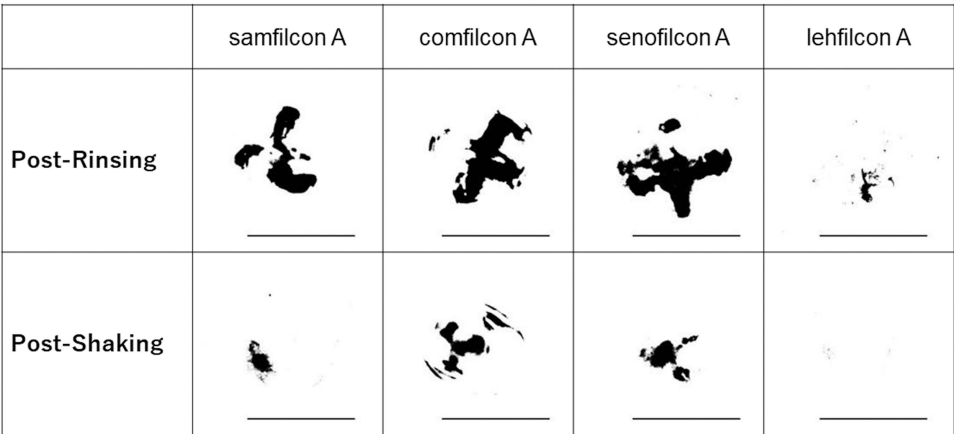


Figure 1 Representative photographs of non-waterproof mascara on the surface of four different silicone hydrogel soft contact lens (SiHySCL) types (samfilcon A, comfilcon A, senofilcon A, and lehfilcon (A) after rinsing and shaking. Compared to the other three lens types, lehfilcon A shows less non-waterproof mascara adhesion after both rinsing and shaking. Bars = 10 mm.

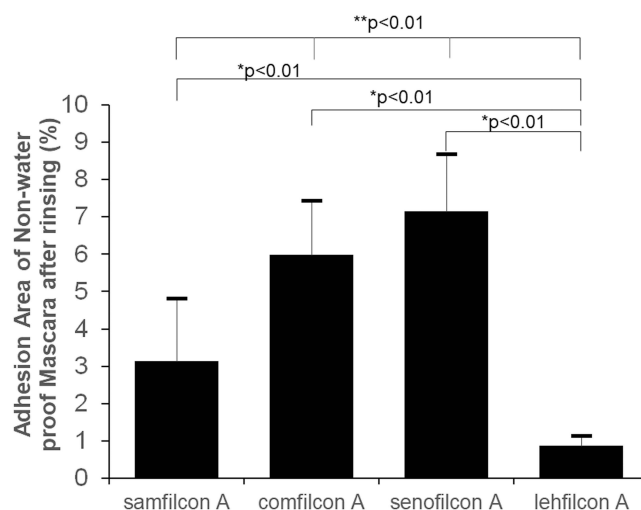


Figure 2 Comparison of the area of non-waterproof mascara adhered to the SCL surface after rinsing SiHySCL on four different SiHySCLs. *The Tukey-Kramer test. ** One-way analysis of variance.

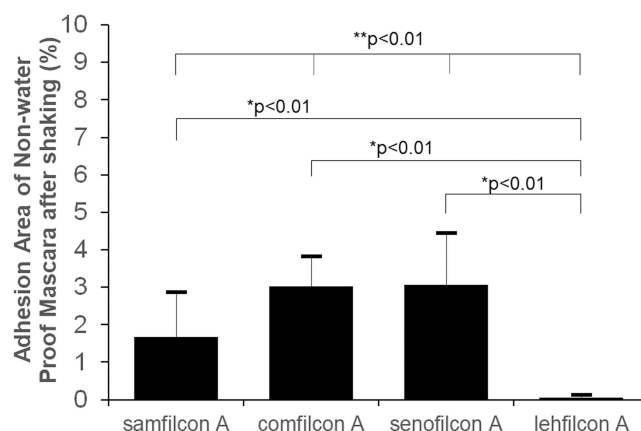


Figure 3 Comparison of non-waterproof mascara adhesion area on SiHySCL surface after shaking SiHySCL on four different SiHySCLs. *The Tukey-Kramer test. ** One-way analysis of variance.

Similarly, after shaking, the percentages of remaining non-water proof mascara areas adhered to the SiHySCL surfaces were: samfilcon A ($1.7 \pm 1.2\%$), comfilcon A ($3.0 \pm 0.8\%$), senofilcon A ($3.1 \pm 1.4\%$), and lehfilcon A ($0.1 \pm 0.0\%$). Once again, lehfilcon A displayed a notably lower percentage of adhered non-water proof mascara areas compared to the other lenses ($p < 0.01$, respectively, as illustrated in Figure 3).

Discussion

In this study, the adherence of artificially deposited non-waterproof mascara particles to lehfilcon A was notably low and was effectively eradicated following washing. The number of particles adhering to lehfilcon A was significantly lower and more easily removed by washing in comparison to samfilcon A, comfilcon A, and senofilcon A, which are widely used lenses in the market. These findings suggest that lehfilcon A exhibits superior resistance to non-waterproof mascara adhesion.

The differences in mascara adhesion among the tested SiHySCLs can be attributed to variations in their surface properties, which are influenced by their material composition and manufacturing technologies. Silicone hydrogel lenses differ in their hydrophilicity, surface roughness, and wettability, all of which can affect the adherence of cosmetic substances. Lehfilcon A, which demonstrated the lowest mascara adhesion, incorporates Water Gradient and Celligent technology. The Water Gradient design creates a highly hydrophilic surface, which likely reduces the interaction between

the lens and hydrophobic mascara components. Additionally, Celligent technology enhances resistance to external contaminants by forming a biomimetic protective layer that limits the adhesion of foreign substances. These unique properties may explain why lehfilcon A exhibited significantly lower mascara adherence compared to other SiHySCLs. Conversely, the other SiHySCLs tested in this study lack these advanced surface modifications, which may have contributed to their higher levels of mascara adhesion. Differences in polymer composition and surface treatments may also play a role in determining the extent of cosmetic adherence.

The surface charge of SCLs influences dust adhesion. In general, Group 1 and 2 SCLs are nonionic and can approach charge neutrality through surface treatments or hydrophilic coatings, minimizing dust adhesion due to static electricity. In contrast, Group 4 SCLs are ionic, and some SiHySCLs incorporate ionic monomers to enhance hydrophilicity, which tends to impart a negative charge to the SCL surface. The SiHySCLs used in this study—samfilcon A, comfilcon A, and senofilcon A—belong to Group 1 and are nonionic, while lehfilcon A falls under Group 2 and is also nonionic. Consequently, all four types of SiHySCLs are theoretically less charged and less likely to attract negatively charged dust particles.

We investigated the mechanism underlying the adherence of non-waterproof mascara to SiHySCLs. Mascara predominantly comprises key constituents such as pigments, moisture, thickeners, filming agents, and preservatives.^{23,24} The pigments used in mascara include both inorganic and synthetic varieties. Inorganic pigments derived from minerals such as iron oxide and titanium dioxide are recognized for their vibrant colors and glossy appearance. In contrast, synthetic pigments and chemically synthesized organic compounds offer a wider spectrum of colors and effects. Notably, pigments, thickeners, filming agents, and preservatives are all chemical compounds known to provoke irritation on the ocular surface.^{25,26} Various factors contribute to mascara adherence to SCLs, including: 1) Powdered Ingredients: Fine particulate elements (such as pigments and ceramides) present in mascara, and have a propensity to adhere to CLs owing to their adhesive properties. (2) Oily components: Mascara formulations often incorporate oily constituents that can adhere to the surface of CLs. These adhesions can result in blurred vision and discomfort when wearing CLs. 3) Application technique: If mascara is applied in close proximity to the lash base, it is more likely for the mascara present on the lashes to adhere to the CLs.

The discussion focuses on the adhesion of mascara to the CL materials. In this study, lehfilcon A exhibited notably lower adhesion to non-waterproof mascara than the other SiHySCLs. Notably, lehfilcon A displayed a water contact angle of 25 °, while comfilcon A exhibited 40 ° and senofilcon A showed 79 °, indicating a smoother surface of lehfilcon A.²⁷ Additionally, research has revealed that lehfilcon A demonstrated higher hydrophilicity and lubricity, coupled with a lower coefficient of friction, than senofilcon C and senofilcon A SCLs.^{28,29} Therefore, the smoother surface and reduced friction of lehfilcon A SCLs suggest their potential protection against non-waterproof mascara adhesions.

Lehfilcon A incorporates biomimetic technology by integrating Celligent Technology, a novel corneal-mimicking advancement, into the existing “Water Gradient Technology” employed in delefilcon A and verofilcon A SCLs with a water gradient structure.^{8–13} This innovative approach is primarily driven by MPC polymers, featuring “phospholipid polar groups” akin to those found in cell membranes.^{17,27} Owing to their high biocompatibility, phospholipid polar groups are extensively used in medical devices, such as catheters and medical tubing. Encapsulating the lens surface of the SiHy base substrate with cross-linked poly-MPC (PMPC) produces a CL surface that mimics the shape, smoothness, and softness akin to the corneal surface.^{17,27}

Prior studies examining MPC-treated SCL surfaces utilized advanced imaging techniques like scanning transmission electron microscopy (STEM) and atomic force microscopy (AFM).¹⁷ The findings revealed that the surface of lehfilcon A, coated with MPC polymer, manifested brush-like structures approximately 300–400 nm long.¹⁷ Notably, the surface morphology of lehfilcon A bears a striking resemblance to microvilli and other microstructures present on the corneal surface.^{17,30} Furthermore, it was distinctly evident that the SCL combined with MPC exhibited a markedly different morphology compared to SiHySCL surfaces lacking the MPC polymer coating.¹⁷

We then examined the defense capabilities of lehfilcon A against protein and bacterial adsorption. Non-clinical studies on SCLs and other biomaterials containing MPC have demonstrated high resistance to protein absorption and bacterial adhesion because of their low friction coefficients in non-clinical investigations.^{15,29,31,32} Correspondingly, previous *in vitro* research has highlighted that lehfilcon A SCLs exhibit superior hydrophilicity, lubricity, and

a reduced coefficient of friction compared to senofilcon C and comfilcon A SCLs.^{28,29} Moreover, studies have shown that lehfilcon A CLs maintain consistent wetting properties immediately after unsealing and after 30 days of daily use.²⁸ Notably, nanoindentation assessments revealed that the surface of lehfilcon A remained soft and durable even after 30 days of daily wear.³³ Notably, lehfilcon A was approximately five times softer than five other commercially available SCLs after 30 days of continuous use (samfilcon A, comfilcon A, senofilcon C, senofilcon A, and fanfilcon A).³³

The discussion focuses on the antifouling characteristics of SCLs against microorganisms. The ocular complications arising from protein and microorganism adsorption onto SCLs hold critical significance, particularly concerning frequent replacement SCLs in contrast to daily disposable counterparts.¹⁵ The application of an MPC polymer to the SCL surface reduces the friction coefficient by over 80%.²⁹ Hydrated MPC polymers effectively deter protein adsorption onto the SCL surface.²⁹ The antifouling properties of lehfilcon A against bacteria were also investigated. Initially, a quantitative bacterial adhesion analysis, conducted using five *Pseudomonas aeruginosa* strains, demonstrated that lehfilcon A exhibited an average of 92.0% less in vitro adhesion of these microbial strains compared to comfilcon A, senofilcon C, samfilcon A, senofilcon A, and fanfilcon A.^{15,34} Additionally, the antifouling characteristics of lehfilcon A against *E. coli* have been documented. In vitro experiments involving the culturing of human blood-derived macrophages and *E. coli* on various surfaces such as glass, tissue culture polystyrene, poly (dimethylsiloxane) (PDMS), and MPC gel surfaces revealed that while cells adhered to glass, tissue culture polystyrene, and PDMS surfaces, there was negligible adhesion of macrophages and bacterial cellular components to MPC gels.³⁵ This indicates that MPC gels form antimicrobial interfaces because of their resistance to bio-adhesion and their antifouling properties.

The adherence of mascara to CLs can significantly affect cleanliness and comfort. Hence, it is advisable to follow these precautions when using mascara: 1) Allow mascara to thoroughly dry before applying CLs, as dry mascara tends to adhere less to CLs. 2) Concentrate the mascara application on the lash tips rather than near the lash base to minimize adherence to CLs. 3) After applying the mascara, the hands are washed, kept clean, and dried well before handling the CLs. 4) CL users should wash their hands before and after wearing CLs to prevent mascara adherence. Nonetheless, on the event of mascara adhering to SCLs, the following actions are suggested: Hydrogen peroxide disinfection has shown efficacy in removing particles adhered to CLs.^{36,37} This method physically eliminates proteins and foreign substances by producing oxygen bubbles through hydrogen peroxide water decomposition.^{36,37} If the mascara adheres to a daily disposable SCL, the lens should be discarded without rinsing and replaced with a new one. Additionally, general mascara users might benefit from using SCLs such as lehfilcon A, which exhibits lower adherence to non-waterproof mascara.

Our study focused on evaluating the surface area of pigment dispersion; however, optical coherence tomography (OCT) has been demonstrated as an effective method for assessing the depth of pigment penetration within cosmetic SCLs.³⁸ Furthermore, as described by Huang and Rhee, pigment adherence can be evaluated using a standardized rub-off test.³⁹ This method involves systematically rubbing the contact lens surface with wetted cotton buds and examining pigment transfer after each rub.³⁹ While our study employed a simple foreign particle adhesion test, the rub-off test provides a practical and standardized approach for assessing pigment adherence. Integrating these methods in future studies may enhance the evaluation of foreign material adhesion to SCLs and contribute to more reliable and reproducible results.

However, this study has many limitations. First, the amount of non-waterproof mascara used in the adhesion study exceeded what typically adheres to SCL surfaces. Given the growing popularity of waterproof mascara in the global market, conducting adhesion studies on SCLs and waterproof mascara could offer valuable insights for both CL and mascara users. Second, the experiments were conducted under controlled laboratory conditions, which do not fully replicate real-world lens wear, where factors such as tear film composition, blinking, and extended wear duration may influence mascara adherence. Third, only non-waterproof mascara was evaluated, whereas other cosmetic products, including waterproof mascara, eyeliner, and foundation, may interact differently with SiHySCL surfaces. Fourth, the sample size was limited to 12 SCLs per type, and larger-scale studies may be beneficial to confirm these findings. Future research should investigate a wider variety of cosmetic products and assess their adhesion properties over prolonged lens

wear. Additionally, in vivo studies involving actual lens wearers could provide further insights into how environmental and physiological factors affect cosmetic adherence to SiHySCLs.

Conclusion

SiHySCLs have the potential to enhance vision and image quality for individuals with refractive errors and higher-order aberrations, and they may become the predominant material for SCLs in the future.⁴⁰ This study aimed to assist CL users in making informed decisions regarding their daily makeup choices. Biomimetic MPC polymers, which form water-wettable and stain-resistant lens surfaces,¹⁵ may significantly reduce the adhesion of lipids, bacteria, mascara, and other cosmetics, as supported by previous research and our findings. Frequent replacement of SCLs, whether for 2-week or 1-month duration, poses a risk of corneal infections if not properly maintained. Opting for CLs that minimize foreign matter and microorganism adhesion coupled with the use of effective CL care solutions could be an effective strategy for mitigating CL contamination. The findings indicate that lehlcon A demonstrated notably lower mascara adhesion, suggesting its potential as a preferred SiHySCL for individuals using non-waterproof mascara.

Data Sharing Statement

The data that support the findings of this study are available from the authors but restrictions apply to the availability of these data, which were used under license from the Teikyo University for the current study, and so are not publicly available. Data are, however, available from the corresponding author upon reasonable request and with permission from the Teikyo University.

Consent for Publication

All listed authors (Tatsuya Mimura and Ryota Nakagomi) have approved the manuscript and agree with its submission to the journal.

Ethics Approval

This study was conducted in accordance with the ethical guidelines of the Declaration of Helsinki (World Medical Association 2013) and the Ethical Guidelines for Medical Health. The procedures conducted were ethically approved by the Ethics Committee of Teikyo University (#Teirin 18-227).

Informed Consent

This is a non-clinical study and patients are not participating in this study. Therefore, obtaining informed consent was not required for this study.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

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