

SCLERAL LENS HYGIENE AND CARE

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ABSTRACT

Scleral lenses (ScCL) are developed using the same material as rigid gas permeable corneal lenses yet the care of scleral lenses differs from corneal lenses. These large diameter rigid gas permeable lenses necessitate hygiene, care and compliance protocol that is more complex compared with corneal lenses. Cleaning, disinfection, storing, rinsing and applying ScCL will be discussed. Practitioners will gain confidence in ScCL care which will provide patients with a better understanding of the steps involved in ScCL disinfection leading to increased patient compliance and increased success rates. In turn, patient education will lower the risk of infection and other complications associated with ScCL.

The development of rigid gas permeable (RGP) materials has revolutionized scleral contact lens (ScCL) use decreasing the main problem of PMMA induced hypoxia¹⁻⁵ leading to increased interest in ScCL among practitioners. A successful fit does not assure continual success wearing ScCL. In addition to clinical skills, providing comprehensive patient recommendations and instructions on ScCL management play a critical role in minimizing and preventing complications.

Microbial keratitis (MK) is the most significant, and widely documented, complication related to contact lens use⁶⁻⁸ and occurs due to non-compliance with care regimes including improper use of care solutions such as mixing up contact lens cleaners with conditioning solutions or using saliva to clean lenses.⁹

Zimmerman and Marks described a case of MK with ScCL wear where the lens was stored in a contaminated storage case with saline solution instead

of disinfecting solution.¹⁰ Severinsky et al reported MK as a complication of ScCL in two patients due to non-compliance from poor cleaning habits.¹¹ Other risky behaviour leading to MK with ScCL included rubbing lenses every 2 weeks rather than daily rubbing.¹²

Three cases of acanthamoeba keratitis (AK) have been documented due to multiple causes of improper ScCL care including the misuse of bottled saline solution, not rubbing lenses during cleaning, and the inherent risks of a ScCL design. Bottled saline solution looks similar to multipurpose solution, and costs less, making it easy to confuse as a substitute for a disinfection product. The misuse of bottled saline solution, which quickly becomes contaminated and provides no disinfection for ScCL, increases the risk for AK. Rubbing the ScCL seems to be a challenge for patients due to the shape and large lens diameter yet is the key to breaking the ScCL adhesion of acanthamoeba. The inability to rub the back surface of the ScCL

compounded with the minimal tear exchange under the lens provides a perfect habitat for growth.¹³ This review will describe protocol and provide instructions for proper care of ScCL leading to decreased complications including MK and AK.

HYGIENE AND CARE USING SCLERAL LENSES

Scleral Lens Care

ScCL care system recommendations are similar to RGP lens solutions including lens cleaning, disinfection, storing and rinsing. The two major differences with corneal RGP lenses compared with ScCL are lens rinsing and filling which should be performed using non-preserved saline.

Cleaning and Lens Cleaners

ScCL should be cleaned by rubbing for a minimum of 15 seconds¹³ and rinsing prior to overnight storage to remove microbes, parasites and debris. This includes lipids and protein from the tear film as well as cosmetics and creams that can adhere to the ScCL during daily wear. Removing debris increases the effectiveness of the disinfection process and helps to maintain lens surface treatments. Rinsing with a saline or multipurpose solution removes the cleaner and all residue from the lens surface. However, almost 80% of wearers failed in rubbing and rinsing lenses.¹⁴

ScCL may be plasma treated or manufactured with Hydra-PEG. Hydra-PEG is a polymer mixture that is permanently bound to the front surface of the ScCL to enhance wettability and lubricity while decreasing deposit formation. Plasma treatment is used to improve initial comfort and wetting by removing contaminants and residue from the lens surface. ScCL treated with plasma should not be handled until dispensed as the treatment wears off easily with daily cleaning.¹⁵ Table 1 outlines the acceptable use of solutions.

Multipurpose Solutions (MPS)

MPS, a non-abrasive cleaning option with excellent disinfection, should be used with caution in ScCL use. The primary advantage of a MPS is the ease of use especially with the elderly or at-risk patient population who may be inclined to mix up multiple care products, therefore increasing the chance of chemical toxicity.

There are three disadvantages of using MPS including:

- **Possibility of inadequate cleaning**, which may result in a hydrophobic and irregular surface maintaining debris attached to the lens.²¹ This may compromise vision and decrease comfort and wearing time;
- **Incomplete removal of the MPS from inside the bowl** of the ScCL, increasing the risk of chemical toxicity to the corneal surface;
- **“Topping off”** which increases the risk of infection.^{13,22}

Table 2 outlines multipurpose disinfecting solutions and their specific purposes.

DISINFECTION AND STORAGE PROCESS

Lenses should be stored overnight in a solution which provides disinfection. Saline solution should not be used because of the high risk of growth of microorganisms responsible for lens and case contamination.

It has been reported that hydrogen peroxide 3% based solutions neutralized with a metallic catalyst were most effective at preventing the formation of biofilm and minimizing contamination, followed by those composed of chlorhexidine which were more effective than the ammonium derivatives such as quaternary or polyaminopropyl.²³

Exposure time to the peroxide depends on level of contamination, type of microorganism, volume of the solution, presence of neutralizing system and concentration of peroxide. Greater concentrations are only marginally more effective compared to 3% hydrogen peroxide. Its biocidal capacity is in the cellular membrane lipid degradation, the denaturation of the protein component attacking the DNA. Peroxide is active with all pathogenic microorganisms (Gram-positive and Gram-negative bacteria, micro bacteria, fungi, lipophilic viruses, hydrophilic viruses, spores).²⁴

A limitation of hydrogen peroxide care systems is that lenses cannot be stored for more than one night because the process of neutralization with the platinum catalytic disc breaks down the hydrogen peroxide into saline solution which does not provide a continuous disinfection process. However, the maximum storage period in the same solution depends on the type of

TABLE 1 Acceptable Solutions for Use with Hydra-PEG and Plasma-Treated ScCL

Type	Product	Plasma Treated	Hydra-PEG	Comments
Solutions Approved for Use with Hydra-PEG ¹⁶	<ul style="list-style-type: none"> • Menicon Unique ph Multipurpose Solution (Menicon) • Boston Simplus (Bausch+Lomb) • Clear Care (Alcon) • Clear Care Plus with HydraGlyde (Alcon). 	No	Yes	
Non-Abrasive Cleaners Containing Isopropyl Alcohol Combined with a Surfactant	<ul style="list-style-type: none"> • Optimum by Lobob Extra Strength Cleaner (Lobob Laboratories), • Opti-free Daily cleaner (Alcon) 	Yes	No	
Cleaners Designed for Low DK Materials	<ul style="list-style-type: none"> • Boston Cleaner Original Formula (Bausch+Lomb) • Boston Advance Cleaner (Bausch+Lomb) 	No	No	May be abrasive and scratch the lens surface ¹⁷
Extra Strength Weekly Cleaners	<ul style="list-style-type: none"> • Boston One-Step Liquid Enzymatic (Bausch+Lomb) • Ultrazyme Enzymatic Cleaner (Abbott Medical Optics) • Progent (Menicon) 	No	No	Risk of disrupting the Hydra-PEG polymer or hastening the disintegration of plasma treatment ¹⁶⁻²⁰

TABLE 2 Multipurpose Disinfecting Solutions and Their Specific Purposes

Solution	Rinse	Clean	Disinfect	Store	Remove Protein
Boston Simplus Multi-Action Solution (Bausch + Lomb)	X	X	X	X	X
Optimum CDS (Lobob Laboratories)		X	X	X	
Menicon GP CDS (Menicon)		X	X	X	
Unique PH Multipurpose Solution (Menicon)		X	X	X	
Boston Advance Comfort Formula Conditioning Solution (Bausch + Lomb)			X	X	
Boston Conditioning Solution (Bausch + Lomb)			X	X	

hydrogen peroxide used and varies from 1–2 weeks depending on the solution.²⁴ It is necessary to rinse the lenses with non-preserved saline prior to lens application in the eye.

A further limitation of hydrogen peroxide storage systems is the small basket case provided which may cause lens chipping and breaking during application and removal from the case. An alternative is to use a larger basket case (e.g., PROSE Disinfection CASE).

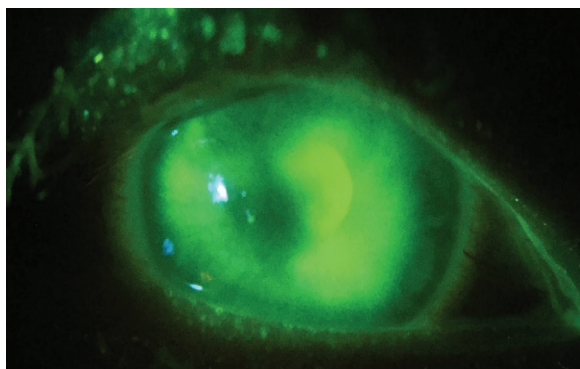
However, a platinum catalytic disc is not included in larger basket cases. Therefore, it is necessary to detach a disc from the smaller case provided with the hydrogen peroxide care system placing the disc in the bottom of the larger case.²⁵ In addition, a multipurpose case with two large compartments may be used. Two platinum catalytic discs are required, one for each lens in the two compartments. However, it must be acknowledged that this alternative is considered off-label.

The addition of compounds in hydrogen peroxide disinfecting solutions, such as glycol propylene, methylcellulose or more recently hydraglyde, allows for an additional lubricating function. The level of compliance with hydrogen peroxide is high because the use of this care system is straightforward. Furthermore, “topping off” hydrogen peroxide solution is impractical. This has been confirmed by the outcomes of a study on soft lens wearers showing that only 37% of patients using multipurpose solutions adhered to the instructions, while patients using hydrogen peroxide solutions with a platinum catalytic disc were found to be 100% compliant.²² Presumably, these considerations, with some caution, may be extended to ScCL wearers. A list of hydrogen peroxide solutions are as follows: Clear Care Cleaning and Disinfection Solution (Alcon), Refine One Step Cleaning and Disinfection Solution (CooperVision), Oxysept Ultracare Disinfecting/Neutralizer Solution (Abbott Medical Optics), and Clear Care Plus Cleaning and Disinfection Solution (Alcon).

Rinsing with Saline Solution

ScCL should be rinsed prior to their application in the eye to remove the cleaning agent preventing irritation and chemical toxicity of the cornea (Figure 1). According to the U.S. Centers for Disease Control and Prevention (CDC) about 91% of RGP lens wearers.

FIG. 1 Chemical toxicity of the cornea in a non-compliant patient. The scleral lens was not rinsed properly to remove the storing solution prior to lens application in the eye.



reported using tap water for lens rinsing and 33% reported storing their lenses in water.²⁶ ScCL should not be exposed to water because bacteria, fungi and protozoa present in tap water may transfer to the lens and remain entrapped in the liquid reservoir behind the lens during wearing time causing severe contamination. Confusion exists between package inserts and doctors' recommendations for not using tap water. Numerous multipurpose solutions advise the use of tap water to rinse the cleaner, disinfecting solution and storage case.^{18,19} Non-compliance increases when the package insert suggests tap water to rinse and the doctor provides contradictory instructions. Patients may not remember what their eye doctor told them over time and will refer to the package insert for guidance.²⁷

Ideally, ScCL should be rinsed with preservative free saline solution. If suggesting a preserved saline solution, the practitioner should emphasize to the patient that preserved saline should be used for lens rinsing only while non-preserved unit-dose saline solution should be used for filling the ScCL prior to application. In cases where the patient may not be compliant, recommend the use of non-preserved saline in a single dose for both ScCL rinsing and filling.

Application Solutions

ScCL vault the cornea creating a liquid reservoir. It is necessary to use a solution to keep the ocular surface hydrated during wear as there is limited tear film exchange which is necessary to hydrate corneal tissue. Since the solution will be in contact with ocular tissues during full time wear, the use of non-preservative solutions is crucial to prevent toxic reactions (Figure 2). A sterile, single dose, non-preservative saline solution is recommended to fill ScCL.

The lenses must be overfilled with preservative free saline until the non-preserved solution appears convex above the lens, preventing air bubble formation. Air bubbles may persist with excessive clearance (500 microns or more) or landing zone not optimally aligned with the underlying sclera. In these cases, the use of a more viscous preservative-free solution may

be suggested. Another condition benefiting from a more viscous solution along with preservative-free, non-buffered saline, is midday fogging.^{28–30}

SCLERAL LENS STORAGE CASE CARE

Lens cases are the most precarious care element because little time is spent explaining proper care.³¹ Contamination of storage cases may be due to bacteria attachment to internal case surfaces acquiring more resistance to disinfecting products from biofilm and diseases such as MK.^{32–35} Factors that may affect lens case contamination are: case type, management protocol and replacement frequency.

Scleral Lens Case Types

Different types of storage cases are available in various organic materials such as polycarbonate, propylene or polyethylene. Cases can be divided into two groups, either impregnated with silver or without additives of antimicrobial action in the polymer blend.

Silver-impregnated contact lens cases contain ionic silver, a non-toxic antimicrobial additive incorporated during the injection moulding process and distributed throughout the entire case. Silver affects bacteria in various mechanisms such as interference with the DNA, destroying the plasma membrane, cellular respiration and sulfhydryl groups.³⁶ The ions present in care system solutions exchange with the silver ions released slowly over time and are extremely effective

in preventing the formation of organic biofilm but does not play a role in the disinfection process.^{36,37} In vitro studies have highlighted the effectiveness of such cases against different bacteria, including *Pseudomonas aeruginosa*. In vivo studies have shown that these cases are more effective than conventional storage cases^{36,37} reducing contamination occurrence by 40%.³⁷

Microblock lens cases (Menicon) are impregnated with argent and are large enough to be used for ScCL storage but are less diffused than those without additives of antibacterial action.

Scleral Lens Case Management

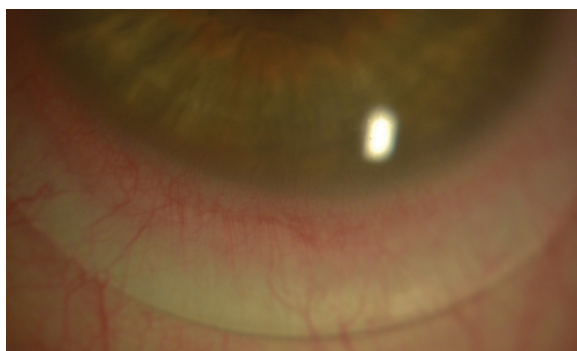
Non-impregnated cases require a different management protocol compared with silver impregnated storage cases. It is essential to adhere to the proper steps based on the type of storage case.

Non-impregnated Cases

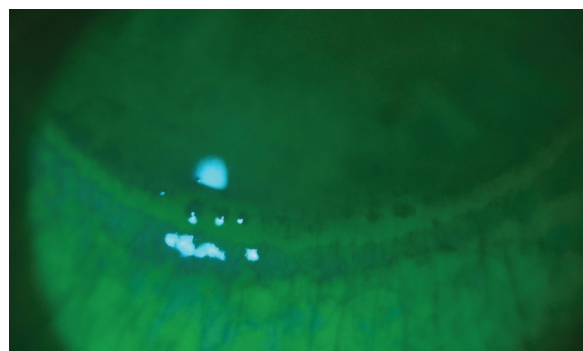
Appropriate management of cases not impregnated with silver requires the following steps:

Step 1: Rubbing and rinsing. Several studies have shown the effectiveness of rubbing and wiping storage cases with a clean tissue to reduce the formation of biofilm.^{38–40} In addition, an extra strength cleaner for contact lenses may be used to clean the case. In this instance, saline solution should be used to rinse the storage case prior to wiping the case with a clean tissue.

FIG. 2 Chronic toxic reaction in the limbal area during the use of scleral lenses filled with Poliquaternium-1 based solution (storing solution) prior to lens application in the eye. (A) limbal hyperemia. (B) limbal hypertrophy appeared at lens removal. (Courtesy of Luigi Lupelli)



A



B

Rubbing lens cases after rinsing hands with tap water increases the incidence of contamination rather than rubbing lens cases after washing hands with soap and water or not rubbing lens cases at all.³⁸ Therefore, contaminants on dirty fingers can be transferred to the lens case or lenses themselves and mechanical friction is actually effective in eliminating or reducing contamination.

Step 2: Tissue-Wiping. While lens case rinsing and air-drying procedures may be commonly recommended, tissue-wiping is rarely suggested by clinicians. All the solutions used for contact lens care are isotonic, containing a small quantity of dissolved salts. Air drying lens cases leads to the evaporation of the liquid parts of the solution letting the salts attach to the case surface. In the evening, the isotonic fresh solution put in the case to store solution will be mixed with the salts remaining on the lens case surface increasing the total quantity of salts in the solution, transforming the fresh solution from isotonic to hypertonic. Therefore, not tissue-wiping the lens case may alter the osmolarity of the solution. Additionally, hypertonic solution may endorse the survival of staphylococcus aureus.⁴¹ Also, it has been reported that friction associated with tissue-wiping led to significant reduction of biofilm especially with smooth cases, even without the rinsing step.³⁸

Step 3: Air Drying. Advisory bodies and the Food and Drug Administration (FDA) strongly recommend air drying lens cases. However, studies in the United States have shown that only 50% of wearers allow cases to air dry.⁴² Wet cases are likely to have high levels of bacteria which is a risk factor for MK.^{43,44}

Additionally, air dry position and location affect the level of contamination. Air drying lens cases face down is widely recommended.^{45,46} However, this position mimics a closed case because the surface below serves as a case cup not allowing air circulation blocking total liquid evaporation. Case cups and basket cases could be positioned face down with a support which allows the placement of the case in such a way as to permit air circulation in both compartments leading to complete liquid evaporation.

It has been shown that location is important with respect to air drying cases face up with higher levels of airborne contamination in the bathroom/bedroom than in a protected area. Storing cases face down minimizes airborne contamination with no meaningful difference whether in the bathroom or other locations.³⁸

Silver Impregnated Cases

If the lens case is impregnated with silver it is crucial to observe the following steps:

Step 1: Rubbing and rinsing. As cases without additives, silver impregnated cases must be rubbed and rinsed.

Step 2: Daily Replacement of Fresh Solution. The ions of argent are activated in the polymer blend of silver impregnated cases when the environment is moist. Therefore, after applying ScCL in the morning, silver impregnated cases cannot be allowed to air dry. It is necessary to replace the disinfecting solution on a daily basis into the silver impregnated storage case.

Step 3: Closing Lens Case. After replacing the disinfecting solution in the case, close the case to prevent the solution from evaporation and air-born contamination. Upon removal of the ScCL, empty the case, rinse with saline solution and refill with fresh solution for lens storage.

Case Replacement Frequency

Care solutions available today may offer a new case allowing for a natural replacement schedule of every 4–6 weeks.⁴⁵ However, the FDA still recommends case replacement after 3 months.⁴⁶ An epidemiological study showed that case replacement longer than three months increases the incidence of MK 6.4 times. A combination of these two actions may diminish MK occurrence by 62%.⁴⁷ Another study found that eliminating tap water and discarding cases monthly resulted in a very low bacterial count creating a low risk of biofilm and microbial contamination.⁴⁸ In summary, it is suggested that patients replace cases monthly or every time a new bottle of disinfecting solution is opened.

CONCLUSIONS

The authors recognize that there is no paper reporting complete instructions on hygiene and care using

ScCL. The goal of this review is to provide detailed guidelines on proper management of ScCL to prevent complications. Many solutions are available for the practitioner to prescribe, providing both an advantage for the practitioner as well as confusion for the patient. Practitioner responsibility is necessary in order to cater the regime to each patient, therefore maximizing the benefit and eliminating uncertainty for the patient.

Practitioners should educate ScCL wearers at each visit on the steps involved with cleaning, disinfecting, rinsing and filling ScCL. Also, emphasis should be placed on managing, disinfecting and replacing storage cases. Emphasizing the importance of hygiene, care and compliance will enhance patient confidence and increase success rates minimizing issues and infections associated with scleral lenses.

DISCLOSURES

Authors disclose any and all conflicts of interest with any institution or product that is mentioned in this manuscript.

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