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Scleral Lens Issues and Complications Related to Handling, Care and Compliance

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Abstract

Scleral contact lens (ScCL) handling may be challenging and is the principle reason for ScCL drop out. ScCL care systems are more intricate than other lens modalities and include solutions for cleaning, disinfection, storing, rinsing, and filling; respecting the use of each solution recommended is fundamental. Planned replacement of the lenses, solutions, case, and plungers are important in order to decrease the risk of adverse events associated with ScCL wear. Compliance is crucial regarding hygiene, solution use, case and plunger care, wear time, follow-up schedule, and handling techniques. Non-compliance may lead to discontinuation of ScCL due to difficulties associated with this unique lens design.

This paper presents complications secondary to handling, care and compliance that clinicians and patients may encounter while wearing ScCL. Instructions are provided to enhance the understanding on management surrounding these issues. This manuscript includes three tables to summarize types of complications, their symptoms, clinical signs, etiology, and management for a quick-find index for easy consultation during daily clinical practice.

Keywords: Scleral contact lens; scleral lens issues; scleral lens complications; scleral lens hygiene; scleral lens care system; scleral lens compliance; scleral lens complications management.

Lens application and removal can be challenging for scleral contact lens (ScCL) wearers. A ScCL requires special care and maintenance over time for best results.[1] Several studies report the common reasons for abandoning ScCL wear to be the difficulty with application and removal.[2–4] Whereas, other studies have debunked difficulties with ScCL handling.[1,5–12]

ScCL complications related to handling are rare and most are managed without any lasting side-effects. It is crucial that patients understand the application and removal process and are trained in handling ScCL as patients may have initial difficulty with this process.[13] Hygiene and compliance are also fundamental in preventing the development of infections.[14–17]

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Table 1. Issues Related to ScCL Handling

Issue	Symptoms & clinical signs	Etiology	Management
Corneal area			
Air bubbles	• Discomfort • Reduced VA • Corneal desiccation • Corneal dellen	• ScCL not filled completely with saline prior to application	➢ Overfill until the solution appears convex over the lens
		• Improper scleral lens application	➢ Educate patient on proper lens application ➢ Use an application device
		• Patients with different difficulties	➢ Use an application device
		• Further recommendations	➢ Use a more viscous solution for lens filling
Abrasion/staining	• Discomfort • Foreign body sensation • Dry eyes • Vertical staining	• Lens handling	➢ Educate patient on proper lens handling ➢ Use application and removal devices
Limbal area			
Prolapse	• Conjunctival tissue in the limbal and corneal area • Neovascularization	• Excessive pressure on the lens during application	➢ Educate patient on proper lens application
Conjunctival area			

Blanching	• Discomfort
	• Whitening of the conjunctiva
	• At lens removal:
	  • Rebound sectorial hyperemia
	  • Conjunctival staining if it occurs with conjunctival impingement
	  • Conjunctival imprint
		• Excessive pressure applied during application	➢ Educate patient on proper lens application

This paper will discuss ScCL problems related to handling, care, and compliance. Management, symptoms, clinical signs and etiology of issues and complications are presented in Tables 1–3. For clarification, issues are referred as non-adverse events and complications as adverse-events. Medical treatments for adverse and non-adverse events should be managed according to the condition.

HANDLING ISSUES

Air Bubbles

Air bubbles may be due to handling issues during application. ScCL should be overfilled until the solution appears convex over the lens. The eye lids should be opened wide holding them tight because they may cause lens decentration creating air bubble formation upon application. If the lens decenters on the plunger or fingers, it is necessary to reposition the lens in order to keep it overfilled with solution.

For patients with high refractive errors, arthritis, hand tremors, missing digits or dexterity issues, ScCL application may be very challenging. The use of an application device may be helpful.

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Table 2. Issues Related to ScCL Care and Compliance

Corneal area			
Staining	• Occasional eye dryness • Foreign body sensation • Occasional eye dryness • Circular or diffuse staining	• Toxicity	➢ Inspect for presence of debris ➢ Verify compliance ➢ Use a hydrogen peroxide system ➢ Choose non-preservative solutions ➢ Choose a non-preserved and non-buffered saline
Epithelial bogging	• Ocular surface water-logged • Irregular staining	• Prolonged immersion of the cornea with a non-preserved saline	➢ Use mixed solutions: non-preserved artificial tears in combination with a sodium chloride solution
Midday fogging	• Discomfort • Dissatisfaction • Reduced VA • Presence of debris in the fluid reservoir • Diffused corneal punctuate staining	• Atopic diseases (milky tear reservoir)	➢ Manage atopic diseases
		• Release of cells from the cornea with preservative sensitivity (mucus debris)	➢ Use preservative-free solutions
		• Further recommendations	➢ Wash eyes with an eyebath in the morning before lens application ➢ ScCL may be applied, removed and reapplied to clear the eye of debris ➢ Remove debris prior to application in the morning with the use of an eye cup ➢ Avoid taking breaks by removing, cleaning and refilling the lenses ➢ Hold a preservative free saline to the edge and squirt the solution into the fluid reservoir ➢ Use a more viscous solution for lens filling
Limbal area			
Epithelial hypertrophy	• Arcuate staining close to the limbus	• Toxicity	➢ See management of "toxicity" in session "Corneal staining"

(*Continued*)

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Table 2. Issues Related to ScCL Care and Compliance (*Continued*)

Conjunctival area			
Redness	• Engorgement of limbal blood vessels	• Toxicity	➢ See management of "toxicity in section on "Corneal "Staining"
		• Excessive pressure upon application	➢ Review application technique
Lens surfaces			
Deposits	• Discomfort • Reduced vision • Variable, some not visible, deposits • Films • Isolated deposits	• Tear film quality and quantity, compliance, hygiene, care system, ScCL material	➢ Rub and rinse the ScCL prior to overnight storage for a minimum of 15 seconds with a non-abrasive cleaner containing isopropyl alcohol combined with surfactant ➢ Rinse with a saline or multipurpose solution ➢ Use a hydrogen peroxide system ➢ Use a weekly cleaner ➢ Rinse ScCL prior to application with preservative free saline solution
		• Use of creams and cosmetics	➢ Apply face cream, eye creams, and make-up after ScCL application ➢ Use a non-oil base make-up ➢ Avoid make-up to the eyelid margin
		• Allergy	➢ Treat allergy ➢ Reduce the exposure to allergent
		• Lid disease	➢ Treat with wipes, warm compresses, cleansing products and massage
		• Use of non-adequate soaps and moisturizers	➢ Use a non-moisturizing soap ➢ Use non-oil-base moisturizers to the eyelid margin
		• Additional recommendations	➢ Use lubrication throughout the day with non-preservative artificial tears ➢ Add plasma treatment or Hydra-PEG™ ➢ Wipe the anterior surface of the ScCL with a moistened cotton swab or plunger

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Table 2. Issues Related to ScCL Care and Compliance (*Continued*)

Poor wettability	• Discomfort • Reduced vision • Reduced wearing time • Greasy non-wetting surface	• Lab-related issues	➢ Clean with a lab-strength cleaner then clean and store
		• Various factors	➢ Care regimen, plunger hygiene, hand soap, cosmetrics and lotions should be verified ➢ Hygiene and compliance are imperative ➢ Soap containing lanolin, moisturizing or oil should be avoided switching to soaps indicated for acne treatment ➢ Insert the ScCL prior to applying make-up and remove before make-up remover is used ➢ Avoid cosmetics inside the eyelid margins ➢ Use a device such as DMV removal plunger, cotton swab or eye shadow applicator to clean the front lens surface while wearing the lens. Place drops of lubrication on the device and rub the ScCL surface with the device ➢ Add plasma treatment or Hydra-PEG™
		• Ocular surface disease	➢ Treat ocular surface disease prior to ScCL application

Corneal Abrasion/Staining

Corneal abrasion related to lens handling is characterized by a vertical staining pattern and may occur in ScCL beginners, elderly patients, those with limited motor skills and poor visual acuity.[18] Beginners should be instructed on the use of application and removal devices. In other patients, the use of application and removal devices may be helpful. The presence of air bubbles underneath a ScCL will induce staining in the shape of a bubble, upon lens removal.

Conjunctival Prolapse

Prolapse occurs in patients who are elderly, have a history of ocular surgeries such as strabismus and retinal surgery, pellucid-marginal degeneration, or dermatochalasis.[19] Prolapse may also develop using excessive pressure during application.[20]

Conjunctival Blanching

Blanching may be artificially induced when applying the lens with excessive pressure, and may appear

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Table 3. Complications Related to ScCL Care and Compliance

Infiltrative events	• Mild discomfort • Foreign body sensation • Photophobia • Heat sensation • Lacrimation • Focal spots of haziness in the limbal area • Leucocytes infiltration	• Overnight wear	➢ Cease lens wearing for 4-20 days ➢ Cease overnight wear switching to daily wear
		• Poor compliance	➢ Increase lens Dk/t ➢ Introduce lid hygiene ➢ Verify care system and ascertain that patient: • Cleans the ScCL daily by rubbing in the palms of the hands for a minimum of 15 seconds with solution containing isopropyl alcohol in combination with a surfactant before the disinfection process • Disinfects ScCL daily • Uses hydrogen peroxide solutions for ScCL disinfection • Uses preservative-free saline solution to fill the ScCL • Rinses the ScCL with preservative-free saline prior to application to remove debris, generally of organic origin, after the disinfection process • Does not "top-off" solutions • Does not use tap water • If the lens case is not impregnated with argent, remove excess solution upon application and cleans, rubbing, rinses, and wipes the storage case with a clean tissue placing the case face down to air dry. If it is a basket case allow the case to air dry face up. • If the lens case is impregnated with argent, after lens application, add solution (saline or storing solution) and close the case.

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Table 3. Complications Related to ScCL Care and Compliance (*Continued*)

			➢ If the care system package contains a new lens case, replace the case every time a new bottle of solution is used. If the care system package does not contain a new storage case, change the storage case after one to three months maximum ➢ Use only application and removal plungers recommended by the practitioner ➢ Disinfect application and removal devices after each use and air dry the devices on a clean tissue ➢ Replace plungers every 3 months or before if they are damaged ➢ Avoid placing lens storage cases in the bathroom
Microbial keratitis	• Foreign body sensation • Severe pain • Photophobia • Vision loss • Epithelial staining • Infiltration • Increased lacrimation • Area of localized tissue necrosis • Epiphora • Hyperemia • Swollen lids • Ulcer • Anterior chamber reaction	• Overnight wear	➢ See management of "Overnight wear" in session "infiltrative events"
		• Poor compliance	➢ See management of "Poor compliance" in session "infiltrative events"
Conjunctival area			
Giant papillary conjunctivitis	• Lens awareness • Foreign body sensation • Reduced wearing time • Large papillary excrescences on the upper conjunctiva • Tarsal hyperemia • Mucous formation	• Mechanical irritation, toxic reaction, or allergic factor by deposits on lens surface	➢ See management of "deposits"

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circumferential or sectorial. In this case, blanching occurs immediately after lens application and will disappear over time.

CARE AND COMPLIANCE ISSUES

Corneal Staining

Diffused staining may be caused by toxicity to preserved solutions, improper lens rinsing, or contaminated reservoir. This type of corneal staining is similar to solution-induced corneal staining as observed with soft contact lens wear.[21]

Prolonged direct contact of the residual preserved solutions with the corneal tissue and minimal tear exchange underneath the lens cause toxic reactions. ScCL should be rinsed properly with a non-preserved saline prior to application removing cleaning and disinfecting solutions that remain on the lens. Diffused staining may also be due to toxicity to the fluid reservoir containing debris.[18]

Epithelial Bogging

After lens removal the ocular surface may appear irregular and look "waterlogged."[22] The etiology of epithelial bogging is unclear, however, one hypothesis is prolonged immersion of the corneal epithelium with a non-preserved saline not containing nutrients to the cornea. Epithelial bogging is asymptomatic and may be considered benign since it is solved a few hours after ScCL removal.

Midday Fogging (MDF)

MDF may be caused by cells released normally from the cornea which remain entrapped in the fluid reservoir. This is observed in patients using solutions which are incompatible with their ocular surface. Preservative-free care solutions such as hydrogen peroxide care systems may be indicated.

Holding preservative free saline to the lens edge and squirting the solution underneath the lens to remove the debris without disturbing the delicate ocular surface may be recommended. Removal of debris prior to application in the morning with the use of an eye cup will decrease initial accumulation underneath the lens. Disinfect the eyecup after each use. The lens itself may also be used as an eye cup by applying, removing and reapplying the ScCL.

Limbal Hypertrophy

Limbal hypertrophy appears as arcuate staining adjacent to the limbus caused by toxicity. Review the ScCL rinsing process to remove cleaning agents and disinfecting solutions prior to application and confirm the use of non-preservative saline to fill the ScCL.

Conjunctival Hyperemia

Conjunctival hyperemia may be caused by a toxic reaction. The use of preserved solutions or inadequate ScCL rinsing prior to application may induce toxicity. Conjunctival hyperemia may also occur due to excessive pressure upon application and will disappear as the lens settles on the eye. Discussing lens care at each visit will reduce this risk.

Surface Deposits

Deposits have different origins including allergies, lid diseases, tear film quality, compliance, care system, and hygiene. Proper management of allergies and lid diseases may reduce deposit formation including use of non-moisturizing soap, non-oil based moisturizers to the eyelid margin, avoiding make-up along the lid margin and applying creams and non-oil based make-up after application of the ScCL and removal of ScCL after using make-up remover.

Poor tear film quality due to ocular surface and systemic diseases increases risk of deposits on ScCL. Removal and reapplying the ScCL along with manually cleaning and reapplying the lens within a few minutes will quickly eliminate deposits although this action may be inconvenient, time consuming, and may disturb the ocular surface.[23]

A second method which may be more convenient is on-eye surface cleaning, wiping the anterior surface of the ScCL by applying lubricating or saline solution to the DMV plunger, cotton swab or eye shadow applicator while wearing the lens.

Compliance and care systems also play a role in deposit formation. Switching to a hydrogen peroxide solution for disinfection and storage, with a weekly cleaner, may also be beneficial.[24] Washing and rinsing hands prior to lens handling will remove the hand soap decreasing deposits from microbes on the hands and removing any soap residue.

The surface of rigid gas permeable lens material can contribute to deposit formation with daily wear by becoming rough over time increasing the ability for bacteria to bind to the material.[25] The back surface of a ScCL can form deposits due to its size

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and shape making cleaning difficult, leading to increased deposit formation and risk of eye infections such as microbial keratitis (MK). Rubbing for a minimum of 15 seconds, with a non-abrasive cleaner containing isopropyl alcohol combined with surfactant followed by rinsing with a saline prior to ScCL storage, loosens the adhesion of microbes and deposits on the ScCL surfaces decreasing the risk of keratitis.[26]

Lens Surface Wettability

Wettability refers to how liquid spreads over a surface and may be quantified by measuring the contact angle which is formed between a drop of liquid and the lens surface; a low contact angle indicates good wettability, an increased ability of the tears to spread on the lens surface leading to a more stable tear film.[27–30] The contact angle depends on lens materials.[31] It is important to choose a material with a balanced relationship between oxygen permeability (Dk) and contact angle (Table 4).

Patients predisposed to poor lens wettability are those with ocular diseases needing treatment with eyelid cleaners, warm compresses, topical drops and antibiotics. Diet may help to decrease ocular surface disease including the use of omega-3 and avoiding fats and fried food.[32]

Poor wettability at lens delivery may be due to lab-related over-polishing or the transfer of substances to the lens surfaces during the manufacturing process, shipment or in-office handling. Lens verification and inspection should be performed before patient visits. A poor wetting ScCL should be cleaned with a lab-strength cleaner, then again with a cleaner and then stored in a disinfection care system.[33]

If problems in lens wettability occur over time, care regimen, plunger hygiene, hand soap, cosmetics, and use of lotions should be reviewed. Plungers should be disinfected after each use with alcohol or disinfecting solution and replaced every three to six months as suction tends to diminish and residue may accumulate over time. Make sure the plunger is dry prior to use. Soaps containing lanolin, moisturizers or oil should be avoided by switching to soaps indicated for either acne treatment or contact lens use. Non-preservative artificial tears should be recommended. Also, inspect the lens as increased surface scratching occurs over time, not from lens handling but due to environmental factors including dust particles.[34]

Plasma treatment and Hydra-PEG™ may be indicated. Plasma treated lenses should not be cleaned prior to dispensing the ScCL. Both plasma treatment and Hydra-PEG™ aid in wettability and lubricity with the main difference being that Hydra-PEG™ bonds to the front surface of the lens to decrease deposit formation, while plasma treatment wears off over time helping with initial symptoms related to wettability.

Table 4. Contact Angle and Dk Values of Different GP Materials

Materials	**Contact angle**	**Dk**
Boston XO	49°	100
Boston XO2	38°	141
Contamac Optimum Comfort	6°	54
Contamac Optimum Extra	3°	100
Contamac Optimum Extreme	6°	125
Equalens II	30°	85
Menicon Z	24°	163
Paragon HDS	14.7°	40
Tyro 97	23°	97

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Both plasma treatment and Hydra-PEG coating can be damaged by abrasive cleaning and disinfecting solutions. The list of compatible solutions can be found by contacting the ScCL manufacturing lab.

COMPLICATIONS

Corneal Infiltrative Events

Inflammation response associated with ScCL use has been reported with corneal infiltrates[35] and acute red eye due to poor compliance.[16]

ScCL differs from other modalities because of their sealing effect and reduced tear exchange. Fitting patients with ocular surface disease, the inflammatory mediators released by the ocular surface may be trapped in the fluid reservoir and could create corneal toxicity leading to the onset of corneal infiltrates. Also, the presence of debris in the reservoir and the contaminants released from a normal corneal metabolism may trigger the same reaction.[36]

Poor compliance may also play a role in infiltrative events. Any bacteria contamination in the ScCL case or on the lens itself will be exposed to the ocular surface for a significant time causing bulbar hyperemia and infiltrates.[16]

If infiltrates occur, ScCL wear should be discontinued to allow for resolution. Patients should be instructed again on appropriate hygiene and ScCL care and to be aware of pain, conjunctival and limbal hyperemia. In cases as neutrophic corneas, special attention should be paid to conjunctival hyperemia and ocular redness.[18]

MICROBIAL KERATITIS

Infections using ScCL has been described in compromised corneas. The majority of patients had poor compliance and were taking oral and/or topical corticosteroids which play a role in reducing the immune defense system.[14–17,24,37–39]

Acanthamoeba keratitis (AK) has been documented with ScCL use.[26,39] ScCL cause mild hypoxic changes to the cornea epithelium tissue due to decreased tear exchange and larger lens diameter. This effect can contribute to epithelial micro-erosions that make it easier for organisms, including parasites, to invade the cornea.[26] Other risk factors for AK include dry eye syndrome, autologous tear use and long-term use of systemic corticosteroid.[39]

The incidence of infections with ScCL is not frequent because of several factors. First, ScCL are worn during the day and there are few cases of overnight wear. Second, because ScCL allows continuous corneal hydration, avoiding areas of desiccation, and prevents mechanical irritation from the lids during each blink.[14] Finally, compliance rate concerning hygiene is higher in ScCL wearers compared with other lens modalities because they often have an ocular disease necessitating a particular ocular hygiene.[40]

Giant Papillary Conjunctivitis (GPC)

The lens material itself may play a role in increasing the risk of GPC.[41] Evidence shows that GPC is provoked by mechanical irritation factors related to the tarsal conjunctiva due to deposits (denatured protein) on the lens surface or an edge that is lifted-off. Also, immunological reaction and solution toxicity may cause GPC.[42] Thus, special attention should be addressed to ScCL care. The use of an enzymatic cleaner, hydrogen peroxide solutions or a sodium hyopochlorite-potassium bromide-based solution will aid in removing deposits.

DISCUSSION

Non-compliance may develop with patients who do not follow practitioner's recommendations in aftercare visits, handling techniques, care solutions, care process and general hygiene. Hand washing is oftentimes overlooked and should be discussed and emphasized at each visit to ensure understanding of the importance of this critical step in ScCL care.

Barnett and Lien reported that one third of ScCL wearers discontinued lens wear due to handling issues.[2] In another report, 25% of patients stated that the most common reason for abandoning ScCL wear was difficulty with application and removal[3] and 20% of patients had challenges with placement of lenses.[4]

Other studies showed a much lower rate of abandoning ScCL due to handling problems.[5–10] One study broke down handling difficulty establishing that with application, 20% of patients had mild difficulty while 12% had moderate difficulty; and with removal, only 9% of patients had mild difficulty.[11] Kornberg and Wang found that application and removal was not a laborious process. Most patients reported very

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low subjective difficulty scores with application and removal and took less than 5 minutes to handle the lens after the first week of fitting. All the patients were successful with handling by the fifth week. In addition, application and removal times did not differ by age or diagnosis type. This study dispelled the belief that handling issues would be less difficult for younger patients and confirmed the idea that primary diagnosis does not affect ease of use.[12]

Bhattacharya and Mahadevan studied care and handling experiences in India with patients reporting very little handling-related difficulties. Most patients found handling straightforward. Difficulty in application occurred with older patients with impaired vision. Challenges with removal were due to lens plunger positioning. This study concluded that more training is recommended for patients having difficulty with handling.[1]

Since application and removal seems to be an achievable goal over time, training sessions over multiple visits may be needed in order to prevent abandonment of ScCL wear. Patients struggling with handling can be identified early in the training process. Some patients may require additional visits of application and removal training in order to achieve confidence in handling ScCLs. In these cases, training could be provided and broken down into an application session and removal session with the option of a third session to review care systems.

The care solution and cleaning process of ScCL is more time consuming than other lens modalities.[1] The cleaning process itself has been described as easy for the patient.[1] However, patients seem to mix-up soft and gas permeable care systems while shopping. Therefore, it is fundamental that patients understand the solutions and recommendations provided by the clinician in order to minimize and avoid the ensue of issues and complications.

CONCLUSIONS

The purpose of this paper is to list and explain the risks of improper handling, use of care solutions and poor compliance that practitioners and patients may encounter while fitting ScCL. Clinicians should dedicate the necessary time to instruct the patient on proper ScCL handling techniques, care system and rules for hygiene and the importance of compliance. Brochures, presentations and posters may increase the level of compliance. Clinicians and patients who are aware of the risks are likely to be more diligent. Studies on this topic are needed to truly understand the complications associated with ScCL wear.

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