Contact Lens-related Complications: A Review

Fateme Alipour, MD; Saeed Khaheshi, MD; Mahya Soleimanzadeh, MD; Somayeh Heidarzadeh, MS; Sepideh Heydarzadeh, BS

Eye Research Center, Farabi Eye Hospital, Tehran University of Medical Sciences, Tehran, Iran

Abstract

Contact lens-related problems are common and can result in severe sight-threatening complications or contact lens drop out if not addressed properly. We systematically reviewed the most important and the most common contact lens-related complications and their diagnosis, epidemiology, and management according to the literature published in the last 20 years.

Keywords: Complication; Contact Lens; Contact-lens-related Peripheral Ulcer; Discomfort; Giant Papillary Conjunctivitis; Infectious Keratitis; Superior Epithelial Arcuate Lesion

INTRODUCTION

The use of contact lenses is very common,[1,2] and constitutes a profitable industry.[3] The size of the global market of contact lenses is expected to reach 12,476.3 million US dollars by 2020, at a growth rate of 6.7%.[4]

Contact lenses are prescribed for the management of refractive errors that cannot be addressed by spectacles such as aphakia,[5‑10] keratoconus,[6‑8,11‑18] irregular cornea,[19‑22] and high anisometropia.[6,7,19,20,23] In addition, they can be used for the management of simple refractive errors as alternatives to spectacles. Moreover, contact lenses can be prescribed for the management of dry eye in Stevens-Johnson syndrome[19,23‑27] or Sjogren syndrome,[14,27‑30] post refractive surgery rehabilitation,[11,17,21,31‑33] and persistent epithelial defect.[31,34‑36] Furthermore, the cosmetic usage of contact lenses is very popular nowadays.[37]

Contact lenses have improved the quality of life not only by correcting refractive errors but also by providing better appearance and less restriction in activities.[38] Unfortunately, contact lenses can cause complications that are disappointing for the patients, forcing them to switch from habitual mode of vision correction to other modalities if possible,[39] which are not always simple or complication-free.

The purpose of this review is to provide a better concept of understanding contact lens-related problems. Addressing contact lens problems properly can prevent contact lens drop-out and lessen the consequences.

METHODS

PubMed and Scopus databases were searched for the related articles published from 1995 to 2015 having the keywords “contact lens” and “discomfort” or “complication” in their title, resulting in 819 articles (after exclusion of duplicated and non-related articles). After reviewing the full texts of the articles, 50 articles were chosen. For completing manuscript to be drafted properly, PubMed and Google Scholar were searched again with more detailed keywords. Finally, 139 articles were included in the review.
published between 1982 and 2015 were used for writing this manuscript.

**RESULTS**

Contact lens-related problems are listed in Table 1. We discuss below the main complications in details.

### Contact Lens Discomfort

**Definitions**

According to the Tear Film & Ocular Surface Society (TFOS), contact lens discomfort is a condition characterized by episodic or persistent adverse ocular sensations related to lens wear, either with or without

| Complication                      | Definition                                                                 | Incidence  | Type of lens      | Risk factor                                      | Manage                                                                 |
|-----------------------------------|---------------------------------------------------------------------------|------------|-------------------|-------------------------------------------------|------------------------------------------------------------------------|
| Contact lens discomfort*          | Episodic or persistent adverse ocular sensations related to lens wear    | 23%-94%    | RGP > SCL         | Contact lens properties                         | Treatment of any ocular or systemic disease                           |
|                                   |                                                                          |            |                   | Patients’ factors                                | Modification of environmental factors                                  |
|                                   |                                                                          |            |                   | Medications                                      | Patient education                                                     |
|                                   |                                                                          |            |                   | Compliance                                       | Lubrication                                                           |
|                                   |                                                                          |            |                   | Ocular surface condition                        |                                                                        |
|                                   |                                                                          |            |                   | External environment                             |                                                                        |
|                                   |                                                                          |            |                   | Occupational factors                             |                                                                        |
|                                   |                                                                          |            |                   | Contact lens properties                         |                                                                        |
|                                   |                                                                          |            |                   | Contact lens properties                         |                                                                        |
|                                   |                                                                          |            |                   | Contact lens properties                         |                                                                        |
|                                   |                                                                          |            |                   | Contact lens properties                         |                                                                        |
|                                   |                                                                          |            |                   | Change wearing schedule                         |                                                                        |
| Corneal neovascularization*       | Formation of novel vessels basically found in capillaries and venules of | 1-20%      | SCL > RGP         | High myopia                                      | Contact lens exchange                                                 |
|                                   | the pericorneal plexus                                                    |            |                   | High astigmatism                                 | Changing wearing schedule                                            |
|                                   |                                                                          |            |                   | Improper contact lens alignment                  | Anti-angiogenic therapy                                              |
|                                   |                                                                          |            |                   | Herpes simplex virus                             |                                                                        |
|                                   |                                                                          |            |                   | Post-keratoplasty                                 |                                                                        |
| Superior Epithelial Arcuate Lesion*| Related to hydrophilic Soft contact lens wear                         | 0.2-8%     | SCL > RGP&PMMA    | Contact lens properties                         | Contact lens removal                                                  |
|                                   |                                                                          |            |                   | Corneal shape                                    | Contact lens exchange                                                 |
|                                   |                                                                          |            |                   | Male gender                                      |                                                                        |
|                                   |                                                                          |            |                   | Presbyopia                                       |                                                                        |
|                                   |                                                                          |            |                   | Tight upper lid                                  |                                                                        |
|                                   |                                                                          |            |                   | Steep cornea                                     |                                                                        |
| CLPU*                             | epithelium excavation and Infiltration while bowman layer is intact      | 2-3%       | -                 | Corneal abrasion                                 | Discontinuation of lens                                               |
| Bacterial Keratitis*              | The active inflammation of the cornea caused by microorganisms such as   | 1.2-25.4%  | SCL > RGP         | Hypoxia                                         | Contact lens removal                                                  |
|                                   | bacteria, fungi or parasites as a result of contact lens wear            |            |                   | Microtrauma                                      | Smear and culture                                                     |
|                                   |                                                                          |            |                   | Contamination                                    | Broad spectrum antibiotics                                            |
|                                   |                                                                          |            |                   | Extended wearing                                 | PHMB                                                                   |
| Acanthamoeba Keratitis*           | such as bacteria, fungi or parasites as a result of contact lens wear    | 1-33 per   | SCL > RGP         | Multipurpose solution                            | Chlorhexidine                                                         |
|                                   |                                                                          | million cl |                   | Poor compliance                                  |                                                                        |
|                                   |                                                                          | wearers     |                   | Tap water use                                    |                                                                        |
| Fungal Keratitis *                | ≤ 4.8% of contact lens related keratitis                                  | SCL > RGP  |                   | Extended wearing                                 | Topical & systemic antifungal                                          |
|                                   |                                                                          |            |                   | Hydrogel lenses                                  | Debridement                                                           |
|                                   |                                                                          |            |                   | Trauma (vegetative)                              | Superficial keratoplasty                                              |
|                                   |                                                                          |            |                   | Ocular surface dis.                              |                                                                        |
|                                   |                                                                          |            |                   | Systemic dis                                     |                                                                        |
|                                   |                                                                          |            |                   | Corneal dystrophy                                |                                                                        |

*Contd...*
| Complication                                      | Definition                                                                 | Incidence   | Type of lens | Risk factor                                                                 | Manage                                                                 |
|--------------------------------------------------|---------------------------------------------------------------------------|-------------|--------------|----------------------------------------------------------------------------|------------------------------------------------------------------------|
| Giant Papillary conjunctivitis*                   | Hyperemia and papillary reaction of upper tarsal conjunctiva              | 1.5-47.5%   | SCL > RGP    | Silicone-hydrogel lenses                                                   | Transient removal                                                      |
|                                                  | Screened by the contact lens dry eye questionnaire                        |             |              | Extended wearing                                                           | Lens exchange to Low Dk & Daily disposable lenses  |
|                                                  |                                                                           |             |              | Mechanical trauma                                                          | Cromolyn                                                               |
|                                                  |                                                                           |             |              | Allergy and atopy                                                          | Silicon hydrogel lenses                                               |
|                                                  |                                                                           |             |              | High-water-content hydrogel lens                                            | artificial tears                                                       |
|                                                  |                                                                           |             |              | Lower refractive index                                                     |                                                                        |
|                                                  |                                                                           |             |              | Female                                                                     |                                                                        |
|                                                  |                                                                           |             |              | Increased daily wearing time factors                                       |                                                                        |
|                                                  |                                                                           |             |              |                                                                           |                                                                        |
| Dry eye[^123-125]                                 | Screened by the contact lens dry eye questionnaire                        | 50%         | RGP=SCL      |                                                                           |                                                                        |
|                                                  |                                                                           |             |              | Rectangular                                                                |                                                                        |
|                                                  |                                                                           |             |              |                                                                           |                                                                        |
| Ptosis[^136]                                     | MRD1 ≤1.5mm                                                               | 20 times    | RGP > SC     | Age                                                                        | Surgical                                                              |
|                                                  |                                                                           | higher risk of ptosis                                                  |              | Duration of CL use                                                         |                                                                        |
| Pinguecula[^127]                                 | The appearance of yellowish to brown nodules on the bulbar conjunctiva    | 20% & 23%   | RGP > SCL    | Age                                                                        | Surgical                                                              |
|                                                  | near the sclerocorneal junction                                            | in CL weares compared to 13&14% in non contact (N/T)                    |              | Duration of CL use                                                         |                                                                        |
|                                                  |                                                                           |             |              |                                                                           |                                                                        |
| Corneal Staining[^128]                           | Staining of the cornea after fluoresceine instillation                    | 54%         | RGP=SCL      | Increased daily wearing time, contact lens deposition, the lengthier       | Using silicone hydrogels and high-water-content lenses, decreasing      |
|                                                  |                                                                           |             |              | replacement                                                                | wearing time                                                          |
|                                                  |                                                                           |             |              |                                                                           |                                                                        |
| Corneal edema[^129]                              | Corneal swelling that blurs vision                                        | -           | RGP=SCL      | Extended wear schedule                                                     | Reduce wearing time                                                   |
| Allergy Aggravation[^130]                        | Non-infectious inflammatory reaction to CL or its care solution           | -           | -            | Extended wear schedule                                                     |                                                                        |
|                                                  |                                                                           |             |              | Atopia                                                                     |                                                                        |
|                                                  |                                                                           |             |              |                                                                           |                                                                        |
| Mucine ball[^131]                                | Spherical, translucent, insoluble, substantially rigid, tear film derived| 50% - 82%  | SCL          | Steeper cornea                                                             |                                                                        |
|                                                  | bodies                                                                     |             |              | Continuous wearing                                                         |                                                                        |
|                                                  |                                                                           |             |              |                                                                           |                                                                        |
| Deep stromal opacity[^132]                       | Unusual deep stromal opacities just anterior to Descemet’s membrane       | -           | -            | Low to moderate Dk/t                                                       | Drop Out                                                               |

Contd...
visual disturbance, resulting from reduced compatibility between the contact lens and the ocular environment. This complication can lead to decreased wearing time or even discontinuation of contact lens wear.[40]

These symptoms should occur after the initial period of adaptation and resolve or diminish with contact lens removal. Moreover, CLD may accompany physical signs such as conjunctival hyperemia or ocular surface staining, or may be diagnosed based only on the patient’s subjective report of the discomfort.[40,41]

**Epidemiology**

The CLD prevalence ranges between 23 and 94% among patients who have symptoms attributable to contact lenses. The burden of the problem seems to be high. This wide range can be due to differences in the assessment tools, severity of the stages assessed, sampling methods, inherent factors of the studied population, and time frame between studies.[42-45]

Factors causing CLD can be either contact lens-related or environmental. Contact lens-related factors can be associated with (1) material (lubricity, water content), (2) design (edge, base curve, asphericity), (3) fit, (4) wearing schedule, and (5) care system (chemical composition, regimen).

Environmental factors[42-44] can be subdivided into (1) ocular surface condition (dry eye, tear composition), (2) external environment (humidity, wind, temperature), (3) occupational factors (computer, light, altitude, and other occupational related changes in the external environment), (4) medications, (5) compliance, and other factors (age, gender, background ocular or systemic diseases, psychiatric and psychological conditions). Out of these, young age, female gender, tear quality and quantity, seasonal allergies, psychological factors, the use of some medications, room humidity, and wind and blink-rate altering activities are clinically related to CLD.[42]

**Management**

The goal is to provide comfortable daily wearing time that suffices for the patients’ desired activities; this varies from patient to patient.

The evaluation of predisposing factors for CLD should preferably be started at the first visit and fit. Therefore, meticulous history taking, slit lamp examination, and tear assessment tests for estimating the risk of CLD are required. Potential conditions that can cause CLD, such as blepharitis, meibomian gland dysfunction, and dry eye, should be addressed before starting contact lens use.

Patients who are inherently or occupationally prone to CLD should be advised to use more eye-friendly contact lenses and lens care systems. CLD can be prevented in these highly susceptible patients by daily wearing schedule, more frequently disposable lenses (preferably daily disposable), hydrogen peroxide based care system being more compliant to lens care, and frequent use of lubricating drops patients.

For symptomatic patients, a thorough history taking may reveal the underlying cause of CLD. History should include the timing and course of the symptoms during the day, lens type, care system, wearing pattern and replacement schedule, compliance behavior, coexisting ocular or systemic diseases including allergy, ocular and systemic medications, and personal and environmental risk factors. Any coexisting ocular and systemic diseases unrelated to contact lens use should be treated appropriately. For example, ocular medicamentosa, which is an ocular irritation caused by chemical toxicity of topically applied eye drops (especially those with preservative) or cosmetics, can be confused with CLD. Conjunctival diseases such as pterygium, pinguecula, and conjunctivochalasis can cause ocular discomfort and are aggravated by contact lens use. Corneal diseases such as Salzmann nodules, corneal dystrophies, and recurrent corneal erosion (due to previous trauma or corneal dystrophies) may cause symptoms that mimic CLD. Careful slit lamp examination can reveal these pathologies. If the patient with these anatomical/pathological conditions wishes to continue wearing contact lenses, these problems should be treated either medically or surgically.

The modifiable environmental factors should be addressed first. Increasing room humidity, avoiding being in the direction of windy air conditioners, intermittently looking at far objects during computer work, and adjusting the angle of gaze at the computer monitor are simple modifications that can help.[46,47]

One of the most frequent background causes of CLD is the patients’ non-compliant behavior. Poor compliance with the frequency of contact lens replacement should be addressed by educating the patients and helping them with reminders such as mobile applications.[48] Poor compliance with care system should be addressed by re-educating the patient and emphasizing the effect of lens rubbing. Modifiable environmental and occupational factors should

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**Table 1. Contd...**

| Complication                  | Definition                                                                 | Incidence                     | Type of lens | Risk factor                | Manage          |
|------------------------------|---------------------------------------------------------------------------|------------------------------|--------------|---------------------------|-----------------|
| Herpes Reactivation [62]     | -                                                                         | 95% in CL users vs. 62%, in non CL users | All Types    | number of recurrences no history of antiviral use | Longer time on prophylaxy |

*References are noted in context. SCL, soft contact lenses; RGP, rigid gas permeable; PHMB, polyhexamethylenebiguanide; NSAID, Nonsteroidal anti-inflammatory drug; PMMA, poly-methyl methacrylate; CL, contact lens*
be controlled.\textsuperscript{[49,50]} Using lubricating eye drops can solve the CLD in the mild stages of the problem.\textsuperscript{[51]}

Effective treatments of dry eye diseases with modalities such as punctual plugs have been proposed.\textsuperscript{[52]} Ocular antihistamine drops such as olopatadine and epinastine can decrease CLD symptoms in patients with history of allergic conjunctivitis, even in the absence of symptoms.\textsuperscript{[52,53]} while oral omega-3 fatty acids can decrease dry eye symptoms.\textsuperscript{[51]}

For the patients who remain symptomatic despite the above-mentioned modifications, a trial of changing the lens type to another with a better surface wettability, and more frequent replacement schedule preferably daily disposable can be helpful.\textsuperscript{[54,55]}

**Corneal Neovascularization**

**Definition**
Formation of new vessels basically found in capillaries and venules of the pericorneal plexus, which progress to the corneal stroma [Figure 1].

**Prevalence**
It is reported that 10–30\% of patients diagnosed with corneal neovascularization wear contact lens,\textsuperscript{[56,57]} while corneal neovascularization develops in 1-20\% of contact lens users.\textsuperscript{[58]} Patients who use rigid gas permeable (RGP) or poly-methyl methacrylate (PMMA) lenses have a lower rate of neovascularization.\textsuperscript{[59]} A higher prevalence has been reported in relation to soft contact lenses (SCL), especially in extended wearers.\textsuperscript{[56,59]}

**Risk factors**
Intrinsic lens parameters including material properties (oxygen transmissibility) have an impact on the development of corneal neovascularization.\textsuperscript{[60]} High myopia and astigmatism can probably influence the peripheral thickness of hydrogel SCL, which decreases peripheral oxygen transmissibility and enhances peripheral mechanical friction. Improper lens-corneal alignment, due to exceedingly flat or steep cornea, can result in peripheral hypoxic or mechanical trauma in SCL wearers.\textsuperscript{[60,61]} As the available base curves for soft contact lenses is limited, the problem of poor lens fitting is not surprising.\textsuperscript{[60]}

Other causes for corneal neovascularization include herpes simplex stromal keratitis and corneal transplantation. Indeed, contact lenses are frequently used to address the refractive errors induced by herpetic corneal scars and are themselves associated with increased prevalence of herpetic attacks\textsuperscript{[62]} therefore, contact lens practitioners should be aware of recurrent corneal herpetic ulcers and address them promptly. The risk for corneal neovascularization in the post-penetrating keratoplasty status without active inflammation increases in the presence of (1) suture knots in the host stroma, (2) active blepharitis, or (3) a large recipient bed.\textsuperscript{[60]} Therefore, the possible role of the contact lens, especially poor fit, in the development of corneal neovascularization should be considered in these patients.

**Management**
Exchanging the lens with a more oxygen-permeable contact lens, changing wearing schedule from extended wear to daily wear, switching to RGP lenses instead of soft lenses, and discontinuing contact lenses in cases of active progressive corneal new vessels are recommended.\textsuperscript{[58,60]} Anti-angiogenic therapy of the cornea (subconjunctival or intrastromal), as well as corticosteroids and non-steroidal anti-inflammatory agents, can help in cases with active neovascularizations that may endanger the survival of corneal graft or ocular surface health.\textsuperscript{[64,65]} Laser photocoagulation of new vessels, photodynamic therapy, electrocoagulation, and stem cell transplant are surgical interventions recommended in severe cases.\textsuperscript{[66-70]}

**Contact Lens-related Keratitis**

**Contact lens-related peripheral ulcer**

**Definition**
CLPU is characterized by epithelium excavation and infiltration and an intact Bowman layer, in contrast to
corneal ulcers. Typically, CLPU and corneal ulcers are differentiated by clinical features rather than histological examination. Microbial keratitis is more acute and severe, although overlapped characteristics may cause misdiagnosis. CLPU presents with mild and localized conjunctival injection, and focal infiltration usually less than 1.5 mm, always round or slightly oval in shape, white or white-gray, located at the peripheral cornea. Unlike microbial keratitis, CLPU may be devoid of epithelial defects or present with punctuate epithelial erosions [Figure 2].

Cause
In animal models, CLPU is suggested to occur in the presence of live bacteria (e.g., *Staphylococcus aureus*) and corneal epithelial erosion is necessary. In this theory, bacterial toxins and immunogenic agents that enter via corneal abrasions may cause inflammation, leading to infiltration. CLPU is more common in extended wear lenses, and its rate is increased in association with silicone hydrogel lenses.

Incidence
In symptomatic patients, the incidence of CLPU for daily wear silicone hydrogel lenses is 2–3%, while it increases to 2–6% with extended wear schedules. In asymptomatic patients, CLPU incidence in daily wear and extended wear silicone hydrogel lenses is 7–20% and 6–25%, respectively.

Management
Typically, CLPUs regress spontaneously after discontinuation of the contact lens use. Steroid or non-steroidal anti-inflammatory drops are rarely prescribed, in case microbial keratitis is not suspected.

Microbial Keratitis

Definition
Active inflammation of the cornea caused by microorganisms such as bacteria, viruses, or parasites related to contact lens wear, which is its most important risk factor.

Causes
Keratitis can occur in case of contact lens induced hypoxia, microtrauma, and contamination of the contact lens or contact lens solution. Direct inoculation of microorganisms into the eye when wearing contact lens with dirty hands can also cause keratitis. The risk can be increased up to 20 times with extended wearing schedules, which increase corneal hypoxia. Mechanical microtrauma to the corneal epithelium, represented by punctuate epithelial erosions, has been associated with silicone hydrogel contact lenses despite their higher oxygen permeability. The broken epithelial barrier can be a serious risk factor for developing infectious keratitis.

Management
Infectious keratitis can be effectively prevented by proper lens care. It is the responsibility of contact lens practitioners to educate patients, verify their compliance, and provide them with educational materials. Using opportunities such as weblogs, emails, social networks, and mobile applications for this purpose should be encouraged. If an infectious keratitis occurs despite these measures, it becomes the first priority to (1) eradicate the offensive organism, (2) control the inflammation to prevent disease progression and save the globe and sight, (3) provide appropriate anti-microbial agents, (4) adjust the treatment plan when necessary by closely monitoring the course of the disease, and (5) proceed to surgical interventions if necessary. Situations such as impending corneal perforation, progressing to scleritis or endophthalmitis, which are unresponsive to maximum medical treatments, must be managed surgically.

It should be highlighted that severe cases such as those involving the central part of the cornea, ulcers >3 mm in size, ulcers in immunocompromised patients such as those suffering from diabetes or using corticosteroid or immunosuppressive drugs, one-eyed patients, aggressive progression, resistance to initial treatment, and suspicious fungal or acanthamoebal infections must be referred to an ophthalmologist/ophthalmology hospital expert in managing infectious keratitis.

Bacterial Keratitis

Incidence
The approximate yearly incidence is 2 per 10,000 contact lens wearers, depending on the type of lens and wearing program, with a range between 1.2 (95% coefficient index [CI], 1.1–1.5) for diurnal wear RGP lenses and 25.4 (95% CI, 14.6–29.5) for extended wear of silicon hydrogel lenses. A confounding
factor might be the approval for over-night wearing of the new generations of SCLs, which encourages contact lens wearers to extend the wearing schedule.

The reports on the most frequent causative organisms are not consistent,[82] although Gram-negative organisms are suggested (>70%, Figure 3).[76,77,79-81]

Management
The contact lens should be removed in any suspected keratitis. Smear and culture should be provided separately from the infiltration site, contact lens, and lens case. If the clinical picture cannot easily differentiate between fungal and acanthamoeba keratitis, confocal corneal scan should be considered.[83] Broad-spectrum antibiotic therapy should be started to cover all possible Gram-negative and gram-positive microorganisms. Moreover, attention should be paid toward the most possible organisms, based on the smear results and clinical picture. Antibiotics can be adjusted according to the culture and antibiogram results. Monotherapy with topical fluoroquinolones may be sufficient in small peripheral infiltrations. However, more aggressive therapy with fortified topical antibiotics and loading dose with admission or daily follow-ups should be considered in more severe cases. The choice of the antibiotics varies from center to center, based on the microbial resistance pattern, epidemiology of the keratitis, and drug availability.[84]

Acanthamoeba Keratitis
Definition
Protozoal infection of the eye, principally caused by using contaminated contact lenses or lens solutions. Free-living amoebae of the genus Acanthamoeba are the causal agents of this severe sight-threatening infection of the cornea [Figure 4].

Prevalence
In the United States, an estimated 85% of AK cases are related to contact lenses. In developed countries, the incidence of AK is about 1–33 cases per million contact lens wearers.[85] Indeed, almost 80% of AK cases are associated with soft contact lenses. Although only 12% of AK cases have been attributed to RGP lenses, at least a part of this difference might be related to lower prevalence of RGP lens use compared with soft lenses.[86] However, these figures should not encourage RGP wearers to be less obsessed with their lens care.

Risk factors
Contact lens wear is the main risk factor for AK, which should be considered in any suspicious keratitis in contact lens wearers. Patients with AK can presumably experience pain associated with photophobia, ring-like stromal infiltrate, epithelial defect, radial perineuritis, and lid edema.[86] The clinical picture varies at different stages of the disease and the classical ring-shaped infiltration is seen in advanced stages. Diagnosis of AK requires confocal scan of the cornea or special culture and staining techniques. Delayed diagnosis results in deeper invasion, lower response to treatment, and poorer visual outcomes.[87] Usually, singular amoebae gain access to the lens case through tap water or air, swiftly grow to high densities in the lens if the case is not cleaned correctly and regularly, and subsequently attach to the lens and infect the eye. Wearers of SCLs who use multipurpose solutions are at greater risks given that acanthamoeba sticks particularly well to the hydrophilic plastic of these lenses.[86] Additionally, soft lenses are the most commonly used, also by occasional wearers (e.g., once a week for sport) or cosmetic colored lenses for social events. Indeed, these patterns are risk factors for poor compliance to lens care.[88]

For prophylaxis of any kind of infectious keratitis including AK, the use of tap water is forbidden, the lens case should be cleaned with hand rubbing and subsequently air dried, contact lenses should be cleaned and kept by using a proper cleaning method, and the lens cases must be exchanged at least every three months (preferably monthly).[89] Many multipurpose solutions have added anti-acanthamoeba agents such as polyhexamethylenebiguanide (PHMB), though their effectiveness in the clinical setting needs to be documented. The best method of disinfection remains the two-step hydrogen peroxide systems. Moreover, heat disinfection is highly effective in eradication of the acanthamoeba parasite.[90]

Management
In the case of suspicious AK based on the clinical setting, confocal corneal scan and appropriate culture media (e.g., non-nutrient agar with bacterial overlay or buffered charcoal-yeast extract agar) and staining methods (e.g., acridine orange, calcofluor white, or indirect immunofluorescence antibody) are recommended.
Currently, AK treatment is based on topical antimicrobial agents that can accomplish high concentrations at the infection site.\textsuperscript{[89]} Considering the presence of a cyst form in acanthamoeba, which is totally resistant to therapy, a combined therapy is advisable.\textsuperscript{[91,92]} Chlorhexidine and PHMB are considered the most effective drugs for treating AK infections; especially when combined, they are effective against both cysts and trophozoites.\textsuperscript{[86,93]} Other medications such as neomycin, paromomycin, voriconazole, miconazole, and imidazoles/triazoles family drugs are also effective against acanthamoeba. Failure to response to medical treatment necessitates surgical interventions such as corneal graft.

**Fungal Keratitis**

**Definition**

A sight-threatening complication of contact lenses, characterized by a grayish white infiltration with feathery borders and deep infiltration. Satellite lesions as a hallmark sign may be present, while hypopyon is not uncommon [Figure 5].\textsuperscript{[94,95]} In addition, the diagnosis is confirmed by microbiological tests.

Confocal biomicroscopy can be used to distinguish these infections from other causes and to follow the response to treatment.\textsuperscript{[94,95]}

**Incidence**

In some countries such as India and Nepal, fungal keratitis are the majority of microbial keratitis.\textsuperscript{[95-97]} In 21% of the patients with fungal keratitis, contact lens wear has been documented;\textsuperscript{[98]} whereas this rate was reported to be 10% elsewhere.\textsuperscript{[99]} Fungal pathogens have been found in up to 4.8% of contact lens associated keratitis.\textsuperscript{[98,100]} Candida, Fusarium, and Aspergillus are the most commonly isolated organism.\textsuperscript{[101,102]}

A worldwide outbreak of fungal keratitis in 2006 has been associated with the solution, ReNuMoistureLoc.\textsuperscript{[102]} The rate of fusarium keratitis decreased after recall of this product; however, an increased number of contact lens-related fungal keratitis has been reported in 2007 & 2008, as demonstrated in 78 eyes of fungal keratitis collected from 1999 to 2008.\textsuperscript{[103]}

**Risk factors**

Contact lens wear was the leading risk factor for the fungal keratitis, particularly those caused by yeast-like fungi.\textsuperscript{[94]} Moreover, extended wear schedules increase this risk.\textsuperscript{[98]} Indeed, the risk is highest in extended wear of hydrogel lenses compared with silicone hydrogel, while RGP contact lenses have the lowest risk. Other risk factors include trauma specially with vegetative material, topical steroids and underlying systemic diseases.\textsuperscript{[97,101]}

**Management**

Topical medications commonly used in fungal keratitis include natamycin (5%), amphotericin B (0.15–0.30%), topical voriconazole (1%), and miconazole (1%).\textsuperscript{(101)} In deep infiltrative cases, a systemic therapy may be added. In the cases that do not respond or poorly respond to medical therapy and in patients who suffer from severe thinning impending to perforation, surgical interventions are required. Surgical methods range from debridement and superficial keratectomy in small lesions to penetrating keratoplasty in large lesions.\textsuperscript{[94,104]}

**Giant Papillary Conjunctivitis**

**Definition**

Giant papillary conjunctivitis, also referred to as contact lens-induced papillary conjunctivitis (CLPC), is one of the most common contact lens-related adverse effects.\textsuperscript{[105]} Patients usually complain of irritation, redness, itching, decreased lens tolerance, excessive lens movements (especially superior displacement), and increased mucous discharge. Hyperemia and papillary reaction larger than 0.3 mm are remarkable in upper tarsal conjunctiva.\textsuperscript{[106-108]}

**Incidence**

A CLPC incidence rate of 1.5\textsuperscript{[109]} to 47.5\textsuperscript{[110]} has been reported, with an incidence of 4.6% for wearers of first generation silicone hydrogels.\textsuperscript{[111]} The prevalence of CLPC is higher in patients using silicone hydrogel lenses compared with those wearing hydrogel lenses,\textsuperscript{[112,113]} probably as a consequence of greater mechanical irritation caused by relatively high modulus silicone hydrogel lenses.\textsuperscript{[114]} Moreover, a decrease in CLPC rate has been seen in disposable lens users.\textsuperscript{[107]}

**Risk factors**

CLPC has been associated with certain lens types and lens materials,\textsuperscript{[112]} and is seen more often with
soft contact lenses (85%) compared with rigid contact lenses (15%).[122] Mechanical trauma may play a role in the etiology of this complication.[117] Indeed, a history of allergy and atopy may be present in many cases of CLPC.[106]

Management
It is recommended to consider the possibility of this complication in every visit. Detecting and managing the problem in early stages, even in asymptomatic cases, usually result in the ability to prevent lens drop out. Adherence to lens care recommendations and frequent use of lubricating drops sometimes resolve the problem in its early stages. In both localized and generalized forms of CLPC, it is advisable to discontinue lens wear until signs and symptoms subside, and/or change to a different lens. If symptoms do not resolve, changing to a daily disposable or daily wear schedule can be useful. In the generalized forms, mast cell stabilizers (sodium cromoglycate 2%, ketotifenfumarate 0.05%, levocabastine hydrochloride 0.025%, or olopatadine HCL 0.1%) may be used to manage persistent asymptomatic and recurrent events.[106,108,118,119]

Superior Epithelial Arcuate Lesion
Definition
First characterized in the 1970s, SEALs are corneal complications related to SCL wear that have also been known as epithelial splits or superior arcuate keratopathy. The lesions occur in the superior cornea, within about 2 mm of the superior limbus, between the limbus and the contact lens rim. This lesion can be detected via slit lamp examination of the cornea with the eyelid wide open. It is usually a white or opalescent lesion bearing an epithelial defect, which can be confirmed using fluorescein staining. An irregular shaped epithelial defect surrounded by a superficial and punctate staining is characteristic. Moreover, SCL wearers with SEALs are typically asymptomatic, albeit some of them can suffer from a mild foreign body sensation. SEALs normally present within the first 8 weeks of wearing new or replacement lenses. It can occur in high and low water content SCLs, with daily and extended wear schedules.[120-122]

Recurrence can occur in newly replaced lenses, both of an identical or new design. SEAL has not been reported in relation to RGP or PMMA lenses. Although silicone hydrogel lenses eliminate contact lens complications related to hypoxia, other physical conditions, such as SEAL and papillary conjunctivitis, still arise. SEALs can happen much later with high DK lenses.[122]

Incidence
The incidence of SEAL in the SCL wearing population is obviously low (0.2–8%). Continuous wear, including high DK/t silicon hydrogel lenses can probably result in higher incidence of SEAL in the contact lens wearing population. The incidence of SEAL has been roughly the same between extended wear conventional hydrogel lenses (0.9–4.0%) and continuous wear with first generation silicone hydrogel lenses (0.2–4.5%).[120,121] Moreover, first generation silicone hydrogel lenses showed a higher incidence of complications than the second generation lenses when they were worn on a daily wear basis. Comparing the results of various studies, the reported incidence of SEALs seems to be greater with extended wear than with daily wear.[122]

Risk factor
The combination of lens design, substance and surface properties, and corneal shape are the major parameters for developing SEAL. Patients’ factors include male gender, presbyopia, tight upper lids, and steep cornea. Lens-related contributing factors include lathe cut hydrogel lenses, lenses made of high rigidity or thick materials, monocurve lenses, or plus design lenses.[121]

Management
The patient should stop wearing lenses until resolution of the staining and any infiltration (1–7 days). Subsequently, patients can use the lenses they had been wearing earlier or identical fresh lenses. Nevertheless, if the SEAL recurs, a different lens (in substance and/or design) should be used.[122] All patients should be checked accurately considering the high risk of recurrence and the asymptomatic nature of the lesion. If recurrence occurs after changing lens material or design, soft lenses should be replaced by RGP lenses. Withdrawing contact lens wear temporarily for 1–2 days is normally acceptable for the resolution of the lesion in the majority of cases.[120]

In conclusion, according to our review on the most common and/or important contact lens-related complications by referring to their definition, risk factors, prevalence, and management, these complications are the main cause for contact lens withdrawal. Some complications such as infectious keratitis are sight-threatening. Although this complication is not common, its impact makes it a necessity to be considered. Other complications such as discomfort are more common and, although have little to no effect on vision or eye health, should be considered seriously due to their high impact on the contact lens market. Contact lens practitioners must empower themselves by staying updated.

Acknowledgements
We acknowledge the valuable participation of Dr. Mohammad Soleimani, Assistant Professor at the Emergency Department, Farabi Eye Hospital, who provided the images for fungal and acanthamoebal keratitis from his own archive.

Financial Support and Sponsorship
Nil.
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Conflicts of Interest
There are no conflicts of interest.

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