Review of modern contact lenses and the management of commonly associated complications

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CPD PROGRAMME

Review of modern contact lenses and the management of commonly associated complications

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Contact lenses have grown in popularity over the last decade primarily due to advancements in designs, materials, manufacturing techniques, and improved contact lens-cleaning systems[1]. It is estimated that in the United States alone 41 million wearers exist[2] and worldwide around 125-140 million.[3,4]

A report by the Centers for Disease Control and Prevention estimates more than 80% of contact lens-wearers exhibit at least one behaviour placing them at risk for a contact lens-related eye infection, and nearly 33% of wearers reported previous contact lens-related red or painful eyes requiring medical attention.[2]

Primary care practitioners are often the first to evaluate patients with contact lens-related complications. Although many of these conditions require referral to an optometrist or ophthalmologist, familiarity with present-day contact lenses and their associated complications will ensure prompt diagnosis and management.

Soft lenses

Modern contact-lens wear is dominated by soft contact lenses and accounts for 90% of all contact-lens fittings.[5–7] Although not always optically the best performer,[8,9] the initial comfort of soft lenses positions them as the primarily prescribed lens of choice.[10,11]

Most low- to moderate refractive errors, including presbyopia, can be corrected with soft lenses. However, in high refractive errors and medical conditions where irregular corneal astigmatism is present, such as keratoconus, corneal grafts and post-refractive surgery complications,[12] rigid contact lenses offer improved visual performance.[13-18]

A variety of soft contact-lens modalities exists today, such as daily, two-weekly, monthly or yearly replacement schedules. Monthly disposable lenses are still the most popular prescribed modality,[6] but daily disposable lenses have seen a steady increase and surpassed monthly lenses in countries like Finland and Denmark.[7,19,20]

Soft lens materials are available in either conventional hydrogel or silicone hydrogel materials, with silicone hydrogel lenses the most prescribed due to their improved oxygen transmissibility properties.[1,6,21,22]

Extended wear – where the lenses are worn overnight continuously for up to 30 days – became popular with the launch of silicone hydrogel lenses. Initially, it was thought the increased oxygen transmissibility of silicone hydrogel would negate the risk of developing microbial keratitis typically associated with continuous lens wear.[23] Unfortunately, later research has shown that although the risk is less with silicone hydrogel lenses relative to lower oxygen transmissible materials,[24] extended wear still poses a higher risk for developing microbial keratitis when compared to day-wear lenses.[25]

Rigid lenses

Rigid contact lenses are indicated for all ametropic eyes, but are generally used when soft contact lenses fail to provide adequate vision.[26,27] The rigid optic zone masks all corneal astigmatism and irregularities by creating an artificial smooth front ocular surface for uniform light refraction.[13,16,28]

Rigid lenses can be categorised into rigid corneal-, hybrid-, scleral- and orthokeratology lenses.

Corneal rigid gas-permeable lenses (RGP)

Initially, rigid corneal lenses were manufactured from poly-methyl-methacrylate (PMMA) and were known as hard lenses. Although PMMA was durable and provided excellent optics, it was impermeable to oxygen which resulted in corneal hypoxia-related pathology.[29] Modern rigid lenses are manufactured from gas-permeable materials and are known as rigid gas-permeable (RGP) or simply gas-permeable (GP) lenses.

Corneal RGP lenses rest only on the cornea and are relatively small compared to other lens modalities. The small diameter enables tear exchange beneath the lens to transport fresh oxygen to the cornea upon every blink.[30,31] A well-fitted RGP lens offers excellent vision for all refractive errors, including high astigmatism, masks all irregular astigmatism present in conditions such as keratoconus, has low protein and bacterial adherence and offers excellent oxygen transmissibility.[32-34] (Figure 1)

With the introduction of topography-guided contact-lens design software and improved manufacturing techniques, it is now possible to offer custom-designed GP lenses including aspheric and reverse geometry designs. Reverse geometry designs, where the posterior secondary curve of the lens is steeper relative to the central base curve, are either used for orthokeratology[35] or can be adjusted to conform with the oblate corneal shape introduced by refractive surgery procedures, such as radial keratotomy (RK), excimer photorefractive keratectomy (PRK) and laser *in situ* keratomileusis (LASIK).[36-38] (Figure 2)

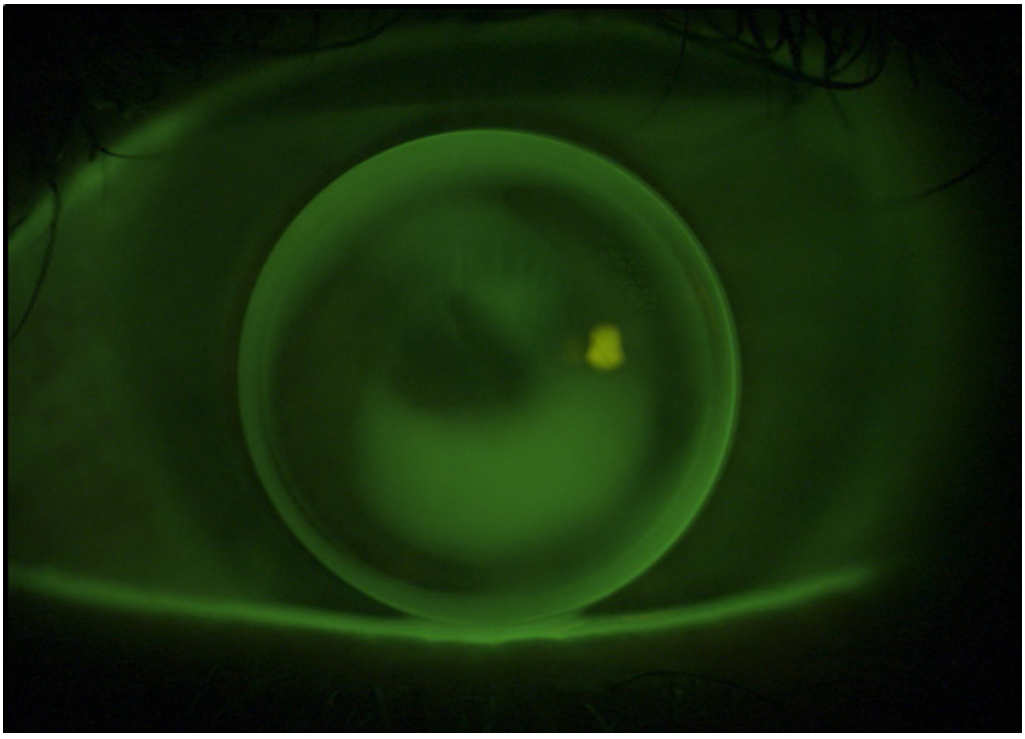

Figure 1. *A corneal gas-permeable lens fitted on a keratoconic cornea. The sodium fluorescein pattern shows the classic three-point or 'feather touch' pattern of an ideal-fitting corneal keratoconus GP lens. Photo: Charl Laas, 2018*

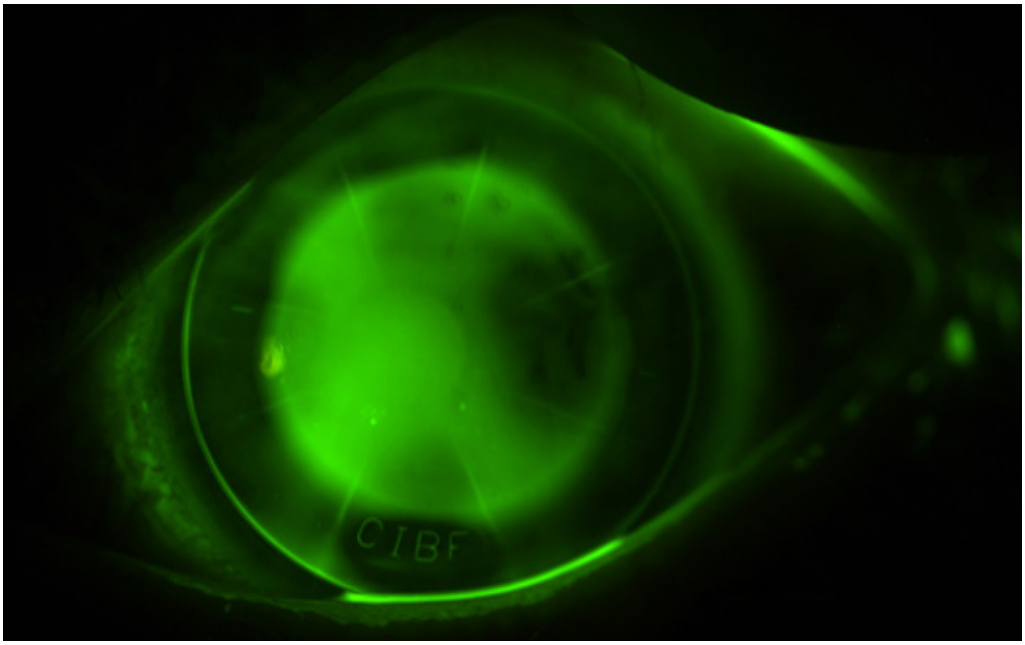

Figure 2. *Sodium fluorescein-stained photo of a software-designed, custom reverse geometry corneal lens fitted on an eye with radial keratotomy refractive surgery, masking the corneal irregularities and restoring optimal sight*

Hybrid lenses

Hybrid lenses consist of a rigid GP centre surrounded by a soft peripheral skirt. These lenses offer the crisp visual optics of a rigid lens, while the soft skirting aids lens centration, provides good initial comfort, and prevents debris getting trapped beneath the lens.

Early-generation hybrid lenses had complications, such as poor tear exchange corneal neovascularisation and tearing at the junction between the soft skirt and GP portion.[39,40] Modern hybrid lenses combine an oxygen-transmissible material for the rigid centre, a stronger junction between the rigid and soft portions and a silicone hydrogel soft skirt, providing improved oxygen flow to the cornea.[41,42]

Hybrid lenses are indicated for regular refractive errors, including astigmatism, myopia, hyperopia and presbyopia, as well as for irregular corneas when corneal GP lenses cannot be tolerated due to poor centration and discomfort.[43] (Figure 3)

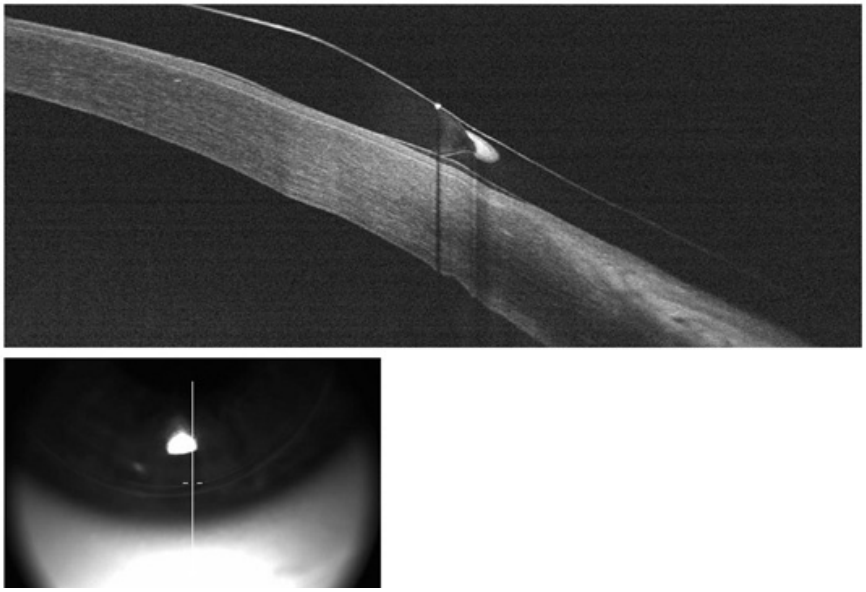

Figure 3. *Ocular coherence tomography (OCT) image showing a cross-section of the junction between the rigid centre and soft peripheral skirt of a hybrid contact lens fitted on an eye. Image: Susan Noeth, 2018*

Scleral lenses

Scleral lenses are large-diameter rigid lenses which vault the entire cornea to rest solely on the sclera. The space between the cornea and the lens is filled with a fluid layer masking and neutralising corneal irregularities and also acts as a liquid bandage in corneal surface diseases such as allergic conjunctivitis, Stevens-Johnson syndrome, graft versus host disease and chemical injury.[18]

Scleral lenses provide a safe and successful vision correction option where other contact lenses and medical treatments fail.[44] They are indicated for standard and high ametropia, corneal therapeutic rehabilitation and correction of irregular corneal conditions, such as keratoconus, pellucid marginal degeneration, corneal grafts and failed radial keratotomy and LASIK refractive surgeries.[45-47] (Figures 4 and 5)

Figures 4 and 5. *Scleral lens fitted on an eye with keratoconus (above) and on an eye with a corneal graft (penetrating keratoplasty) (below). Photos: Charl Laas, 2019*

Orthokeratology

Orthokeratology, or Ortho-K, is an FDA-approved, non-surgical procedure using specially designed reverse-geometry rigid contact lenses to gently and safely[48-50] reshape the corneal curvature of the eye to improve vision.[49–54] Ortho-K lenses are routinely worn at night while sleeping and removed in the morning upon awakening after which the effect of the orthokeratology procedure provides clear vision for the remainder of the day.[55,56] (Figures 6 and 7)

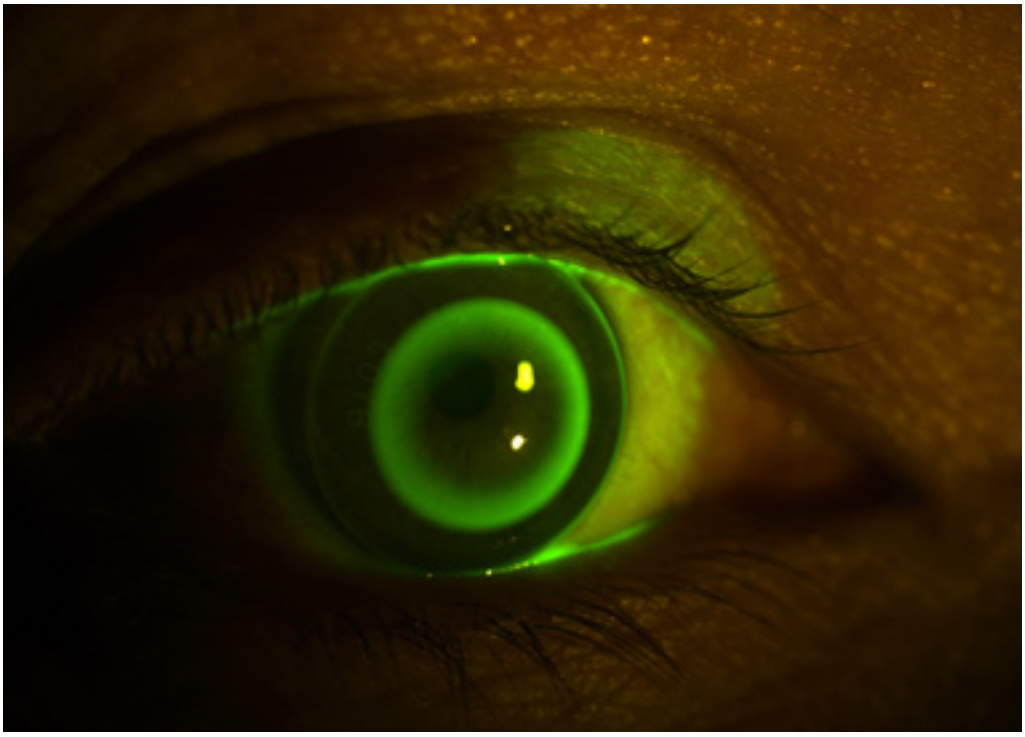

Figure 6. *Orthokeratology lens on the eye stained with sodium fluorescein. Photo: Charl Laas, 2019*

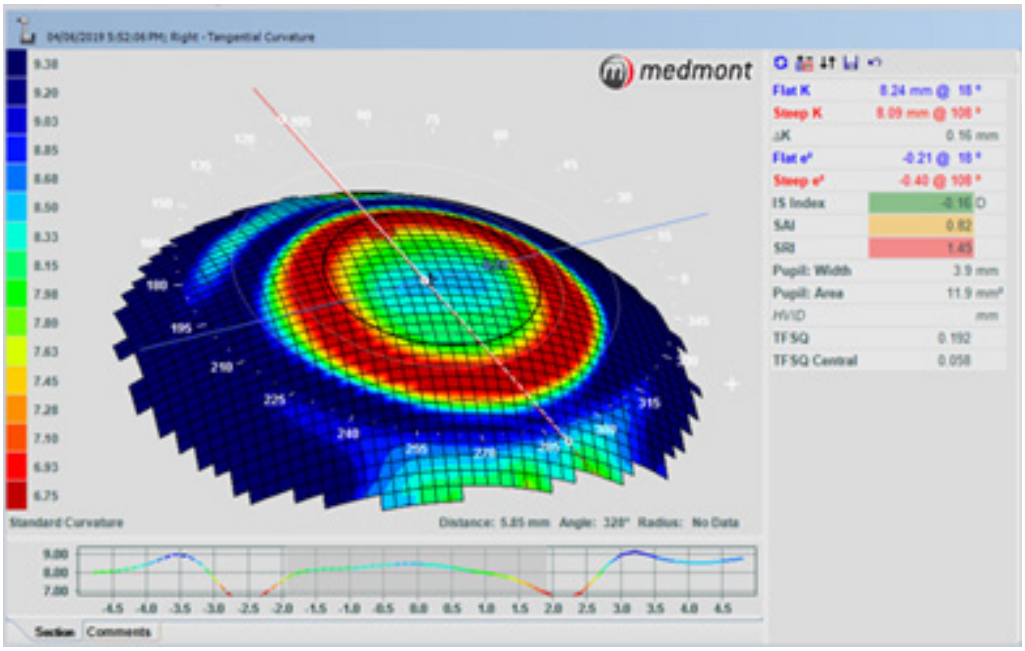

Figure 7. *Tangential curvature topography map of a reshaped orthokeratology eye. The orthokeratology lens flattens the central and steepens the mid-peripheral curvature of the cornea to achieve controlled myopia correction*

Children and contact lenses

Many regard fitting young children with contact lenses as a contentious issue, but research shows the threat to ocular health in children to be no higher than in adults when worn with proper care and maintenance.[57,58] Ametropic children testify to a marked improvement in their self-confidence regarding appearance, social acceptance and participation in sporting activities when wearing contact lenses.[59-61]

Children with anisometropia (refraction difference of more than two dioptres between the two eyes) or aphakia due to injury or congenital cataracts, show improved visual acuity and have a lower risk of developing amblyopia when wearing contact lenses.[62-66]

Another benefit is the ability to slow the progression of myopia. Several recent studies have found orthokeratology lenses, and certain multifocal contact lenses provide a significant amount of myopia control.[67-75] Considering that by current estimates approximately half the world's population will be myopic by the year 2050 and that nearly a billion of these people are at risk of developing high myopia-related pathology,[76] offering myopia control to young, progressive myopic patients has the potential to significantly reduce the risk of visual impairment and blindness later in life.[77]

Common contact lens-related complications

The greatest risk factors for developing contact lens-related complications include poor hygiene, male gender, smoking, blepharitis, improper lens care, extended wear and non-adherence to replacement intervals.[78-81] Interestingly, one study found the highest risk factor for developing contact lens-associated microbial keratitis is wearing soft lenses past their replacement schedule.[82]

Some of the more common contact-lens complications seen in optometric and ophthalmic practices include:

Contact lens-induced papillary conjunctivitis (CLPC)

CLPC is characterised by tiny papillae and hyperaemia on the palpebral conjunctiva, best seen with lid eversion, and often causes discomfort in contact-lens wearers. The term giant papillary conjunctivitis (GPC) is interchangeably used in severe CLPC where the papillae have a cobblestone appearance with a diameter larger than 0.30mm.[83] (Figure 8)

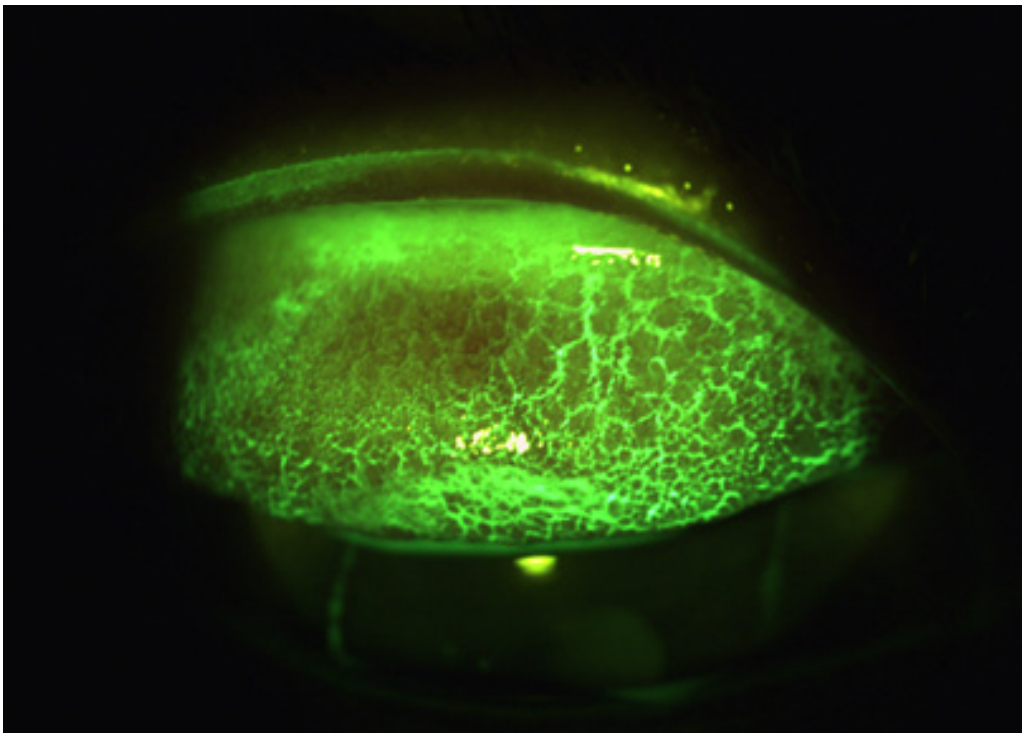

Figure 8. *GPC is characterised by enlarged, irregularly-shaped papillae on the palpebral conjunctiva. Photo: Charl Laas, 2018*

Signs and symptoms

- Enlarged, irregularly-shaped papillae on the palpebral conjunctiva
- Conjunctival hyperaemia
- Increased mucus discharge
- Decreased, fluctuating vision
- Itchiness
- Lens discomfort and premature discarding

Aetiology

The aetiology of contact lens-induced papillary conjunctivitis is not fully understood, but is considered to be multifactorial. Evidence suggests CLPC is an immunological response to contact lenses (more commonly soft lenses[84]), deposits on the lenses, contact-lens solutions or preservatives in the solutions. Contact-lens contaminants like protein deposits, lipids, calcium, mucus, albumin and contact-lens solution preservatives are implicated as antigenic stimulants to type 1 immunoglobulin type E (IgE) immediate hypersensitivity and type IV T cell, basophil-rich, delayed hypersensitivity.[85-87]

CLPC also occurs secondary to direct mechanical irritation or injury leading to non-specific inflammation of the palpebral conjunctiva.[88] The mechanical trauma causes numerous mast cells to degranulate, releasing a wide range of preformed inflammatory mediators, such as histamine, protease, proteoglycans and cytokines, as well as producing inflammatory mediators, such as prostaglandins, eosinophils, leukotrienes, chemokines and neutrophil chemotactic factor (NCF).[89-92] The elevated presence of NCF, released from injured conjunctival cells, is highly suggestive of a mechanical cause in CLPC.[93]

Although contact-lens wear is the predominant factor for mechanical irritation, other causes can include plastic ocular prosthesis, elevated calcific plaques, extruded scleral buckles, elevated corneal deposits, exposed nylon sutures and elevated filtering blebs.[94-98]

Some studies suggest atopic individuals are also more susceptible to developing CLPC with a peak in onset during the allergy season.[99]

There is also evidence pointing to an association between CLPC and Meibomian Gland Dysfunction (MGD). Studies report significantly more meibomian gland drop-out and greater meibum viscosity, with resulting tear-film instability, in contact-lens wearers with CLPC.[100,101]

Differential diagnosis

- Keratitis sicca
- Acne rosacea
- Chlamydial disease
- Seasonal or perennial allergic conjunctivitis
- Vernal keratoconjunctivitis
- Atopic keratoconjunctivitis
- Superior limbic keratoconjunctivitis
- Viral conjunctivitis (distinguish papillae from follicles)
- Bacterial conjunctivitis

Treatment and management

The aim of CLPC treatment is continual contact-lens wear with the most effective and least intrusive therapeutic programme. Cessation of contact-lens wear should only be considered as a last resort.

Mild cases

- Switch contact-lens cleaning solution to a hydrogen peroxide-based disinfectant system.
- Clean deposits on soft contact lenses with a proteolytic enzyme or replace the contact lenses.
- Polish, adjust or replace GP lenses or ocular prostheses.
- Use hot/cold compresses over eyelids for symptomatic relief and instruct the patient to NEVER rub their eyes.
- Administer preservative-free artificial tears to flush the allergens when necessary.

- Use topical combination antihistamine-mast cell stabilisers like epinastine, olopatadine and ketotifen fumarate b.i.d. for a minimum of three weeks.

Severe cases
- Fluorometholone, tapered from q.i.d.(week 1), t.i.d.(week 2), b.i.d.(week 3) to o.d.(week 4).
- Dexamethasone eye ointment nightly in severe cases for 1 month only. Review intra-ocular pressure on day one, and week two for possible steroid responders.
- Reduce or halt contact-lens wear.

Refer the patient to a contact-lens practitioner for lens design, material and replacement schedule review.

Superficial punctate staining
Superficial punctate staining is characterised by fine multiple pinpoint breaks in the corneal epithelium, which stains with sodium fluorescein, and can appear confluent in severe cases.[102] (Figure 9)

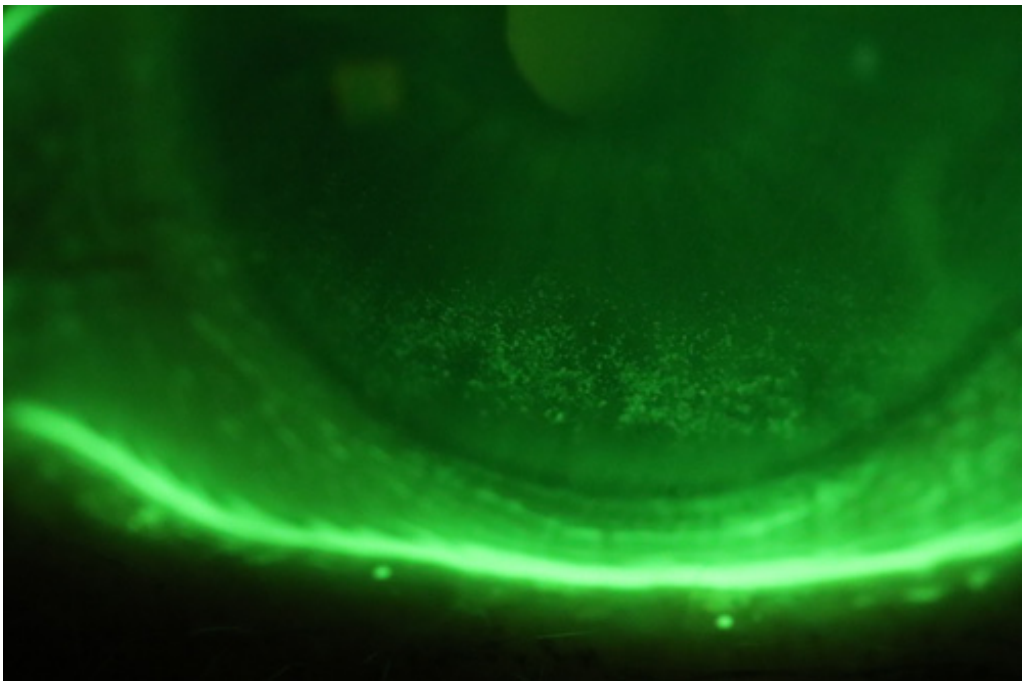

Figure 9. *Diffuse inferior superficial punctate staining due to dryness of the eye and contact-lens wear. Photo: Sherrie Esterhuizen, 2019*

Signs and symptoms
- Multiple small epithelial lesions are visible with sodium fluorescein.
- If the abrasion is superficial, it may go largely unnoticed.

Deeper lesions will result in:
- Discomfort (foreign body sensation)
- Excessive tearing
- Pain
- Photophobia
- Mild hyperaemia

Aetiology
Superficial punctate staining is believed to be a hyper-fluorescence of sodium fluorescein observed from epithelial cells undergoing apoptosis,[103] is non-specific, and has multiple causes categorised as either mechanical, exposure-related, metabolic, toxic, allergic or infectious.[104,105]

In contact lens-related superficial punctate staining, abrasion can be caused by lens imperfections, dirty contact lenses, contact-lens-solution toxicity, foreign bodies under the lens, deposits on the lens, incorrect lens design, overnight contact-lens wear and fingernail scratching due to improper lens insertion and removal technique.[106-111] (Figure 10)

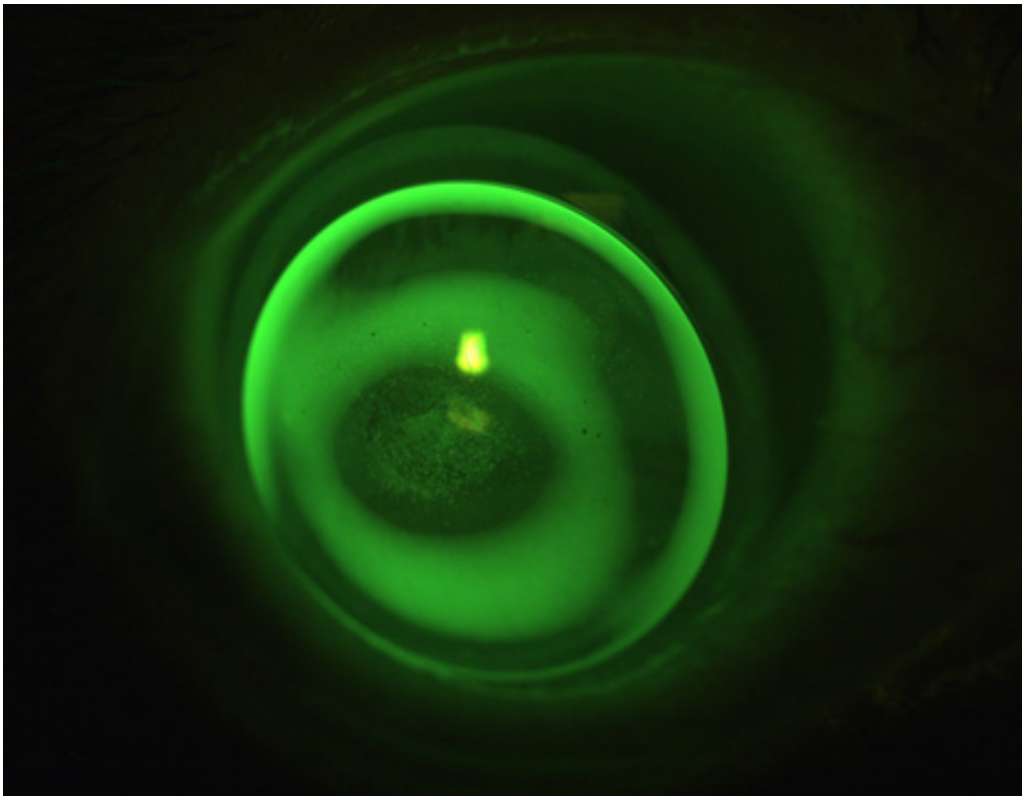

Figure 10. *Central corneal abrasion due to a too-flat-fitting rigid corneal lens on a keratoconus eye. This case requires an immediate refit or will otherwise result in a central scar and loss of visual acuity. Photo: Charl Laas, 2018*

Differential diagnosis

- Corneal ulcer
- Viral dendrites
- Refractive surgery scars

Treatment and management

Mild cases

- Administer preservative-free artificial tears/gels four to six times per day.
- Manage the cause of the epithelial breaks or consider discontinuation of lens wear.

Severe cases

- Discontinue lens wear.
- For more severe abrasions, prescribe a prophylactic topical antibiotic, e.g. tobramycin, q.i.d. to 6x daily.
- To combat antibiotic resistance, it is recommended to reserve topical fluoroquinolone (e.g. ciprofloxacin, levofloxacin, ofloxacin, gatifloxacin and moxifloxacin) for more severe bacterial keratitis and ulcerative conditions.
- Consider oral pain management, if necessary.
- Topical anaesthetic should be limited to initial examination as long-term use can lead to corneal toxicity and delayed wound-healing, leading to ulcers.[112-114]

For contact lens-related superficial punctate staining, refer the patient to the contact-lens practitioner for a lens refit.

Contact lens-associated corneal infiltrative events

Contact lens-associated corneal infiltrates appear as either a diffuse band of haziness or focal spots of haziness in any region of the cornea, with infiltrates located centrally considered clinically more severe than those found in the periphery.[115] Corneal infiltrative events are the result of the corneal inflammatory cascade causing the aggregation of white blood cells, typically polymorphonuclear leukocytes, released

from the limbal blood vessels in response to corneal insult,[116] such as bacterial toxins, enzymes and byproducts on the lens.[80]

Initially, self-limiting corneal infiltrates may look very similar to corneal infiltrative events, leading to potentially sight-threatening microbial keratitis,[117] with *Pseudomonas aeruginosa* (bacterial) and *Acanthamoeba* (protozoal) the most common pathogens.[118-121] It is therefore important to accurately diagnose and manage infiltrative events.

Numerous classification systems to distinguish contact lens-associated infiltrative events exist in the literature. The classification schema proposed by Sweeney *et al*[122] is one of the more commonly used systems today.[119,123-125] although it is challenged by some due to the overlapping nature of the diagnosing signs and symptoms.[126,127] (Figure 11)

The schema divides infiltrative events into:

- Clinically non-significant and asymptomatic (asymptomatic infiltrative keratitis and asymptomatic infiltrates)
- Clinically significant and symptomatic (infiltrative keratitis, contact lens-induced acute red eye, contact lens-induced peripheral ulcer)
- Serious and symptomatic (bacterial, protozoal and fungal keratitis)

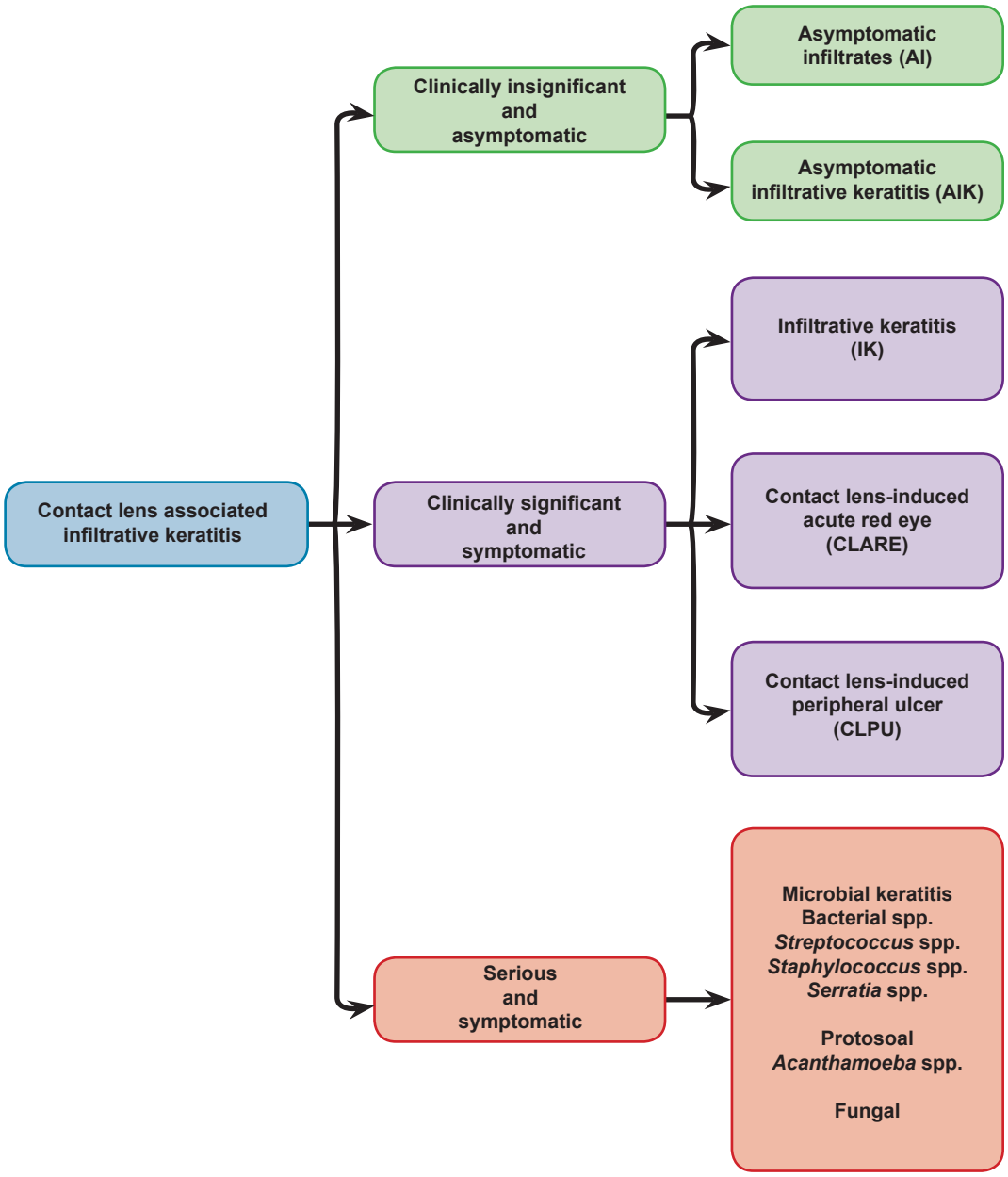

Figure 11. *Classification scheme of contact lens-associated infiltrative keratitis*

Asymptomatic infiltrates (AI)

Asymptomatic infiltrates is an asymptomatic inflammatory event characterised by anterior mild stromal infiltration and is seen in both contact-lens wearers and non-contact-lens wearers. (Figure 12)

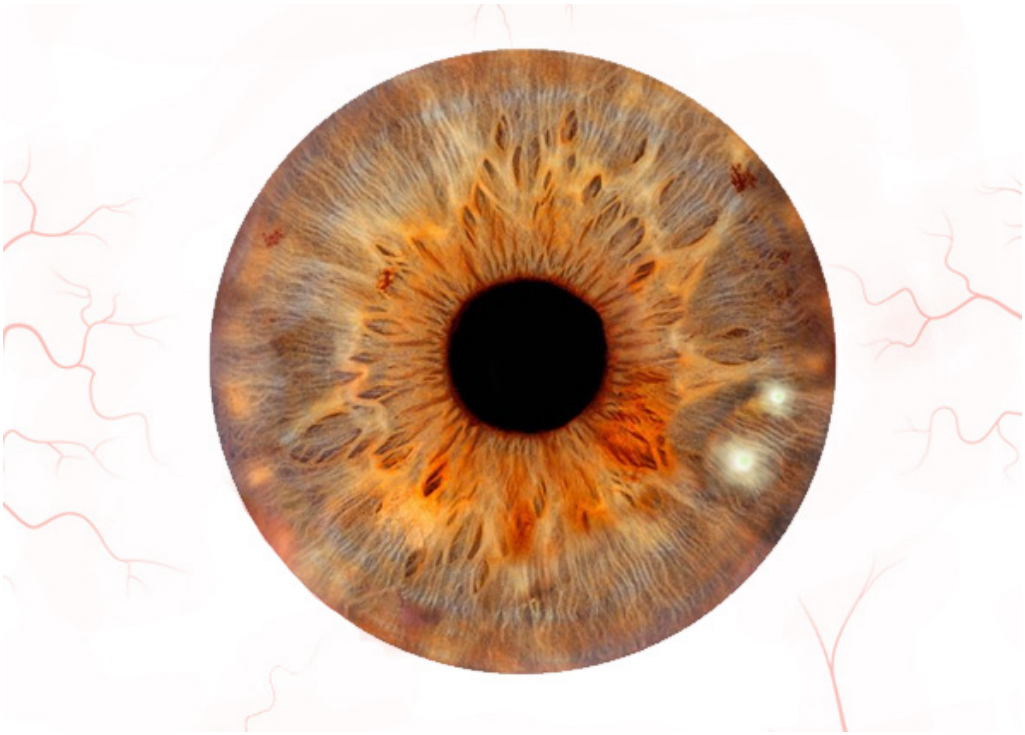

Figure 12. *Asymptomatic infiltrates are characterised by a low number of small infiltrates with no punctate staining. Image: Roan Laas, 2019*

Signs and symptoms

- Uni- or bilateral
- A low number (<2) of small (<0.20 mm diameter), focal and/or diffuse infiltrates
- No punctate staining
- None to slight conjunctival hyperaemia

Aetiology

It is not sure if the aetiology of asymptomatic infiltrates form part of the spectrum of infiltrates associated with contact-lens wear as some studies showed mild infiltrates with no epithelial breaks can occur idiopathically in non-contact-lens wearers as well.[128,129]

When corneal infiltrates are linked to contact-lens wear they may stem from an array of causes, such as lens material and design, lens-wearing and -cleaning schedules, contact-lens disinfection solutions, or environmental factors.

Differential diagnosis

- Corneal scars
- Other infiltrative events
- Viral infections such as H. simplex or H. zoster
- Microbial keratitis
- *Acanthamoeba keratitis*

Treatment and management

- Remove contact lens until the infiltrates resolves
- Unpreserved, sterile saline or artificial tears t.i.d to 10x daily.

Asymptomatic infiltrative keratitis (AIK)

Asymptomatic infiltrative keratitis is an asymptomatic inflammatory event characterised by infiltration of the cornea with associated punctate staining. (Figure 13)

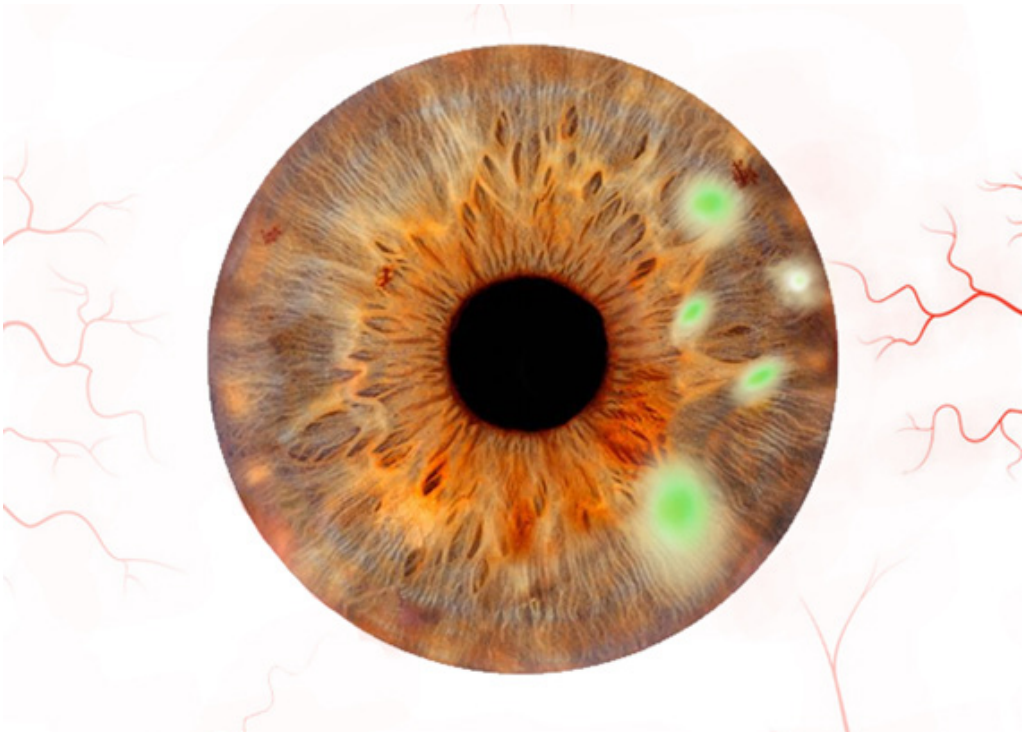

Figure 13. *Asymptomatic infiltrative keratitis is characterised by diffuse infiltration of the peripheral cornea with associated punctuate staining. Image: Roan Laas, 2019*

Signs and symptoms

- Uni- or bilateral
- Slight-to-moderate diffuse infiltration in the peripheral cornea
- With or without small (up to 0.40 mm in diameter) focal or multiple infiltrates
- Associated punctate staining can be present
- Mild-to-moderate bulbar and limbal hyperaemia

Aetiology

The aetiology of asymptomatic infiltrative keratitis is not well established, but Sweeney *et al*[122] proposed that AIK is a normal protective immunological response of the cornea. Sankaridurg *et al* suggested gram-negative bacterial colonisation of lenses is likely to play a role in some cases of AIK.[130]

Differential diagnosis

- Corneal scars
- Other infiltrative events, such as CLARE or CLPU
- Viral infections such as H. simplex or H. zoster
- Microbial keratitis
- *Acanthamoeba keratitis*

Treatment and management

- Remove contact lens(es) until the infiltrate(s) resolves
- Unpreserved, sterile saline or artificial tears t.i.d to 10x daily.
- Prophylactic antibiotics if epithelium is compromised, e.g. tobramycin q.i.d.

Infiltrative keratitis (IK)

Infiltrative keratitis is a unilateral inflammatory reaction of the cornea characterised by irregularly-shaped, single to multiple small infiltrates with superficial punctate staining. (Figures 14 and 15)

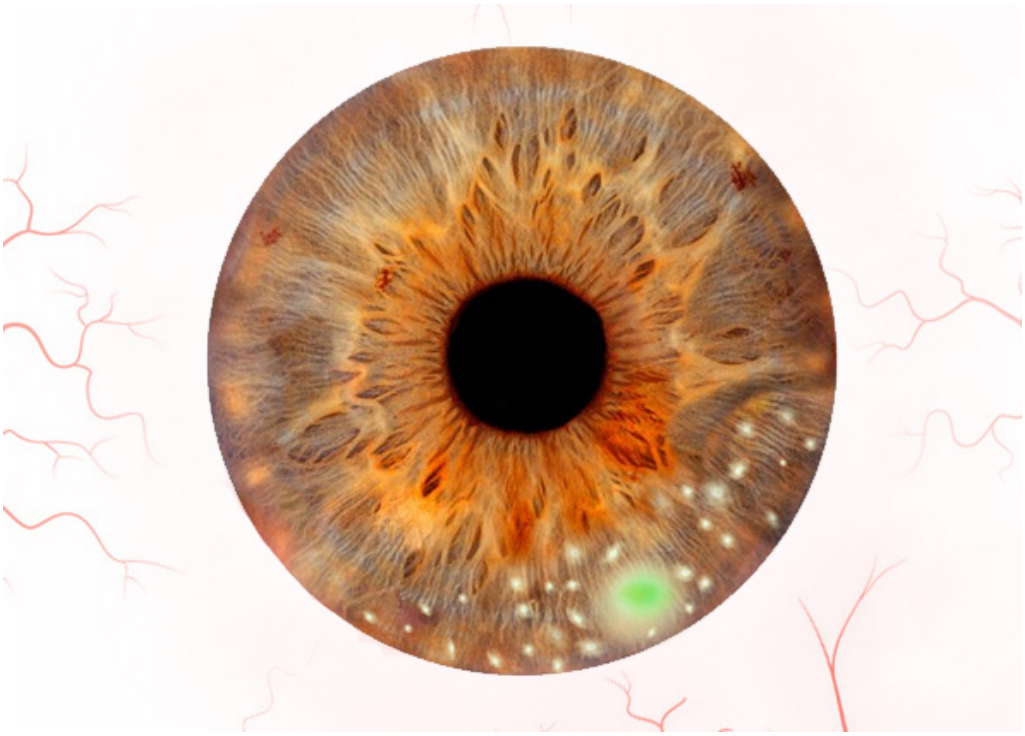

Figure 14. *Infiltrative keratitis is characterised by small, irregularly-shaped focal infiltrates normally with overlaying superficial punctuate staining and mild bulbar and limbal injection. Image: Roan Laas, 2019*

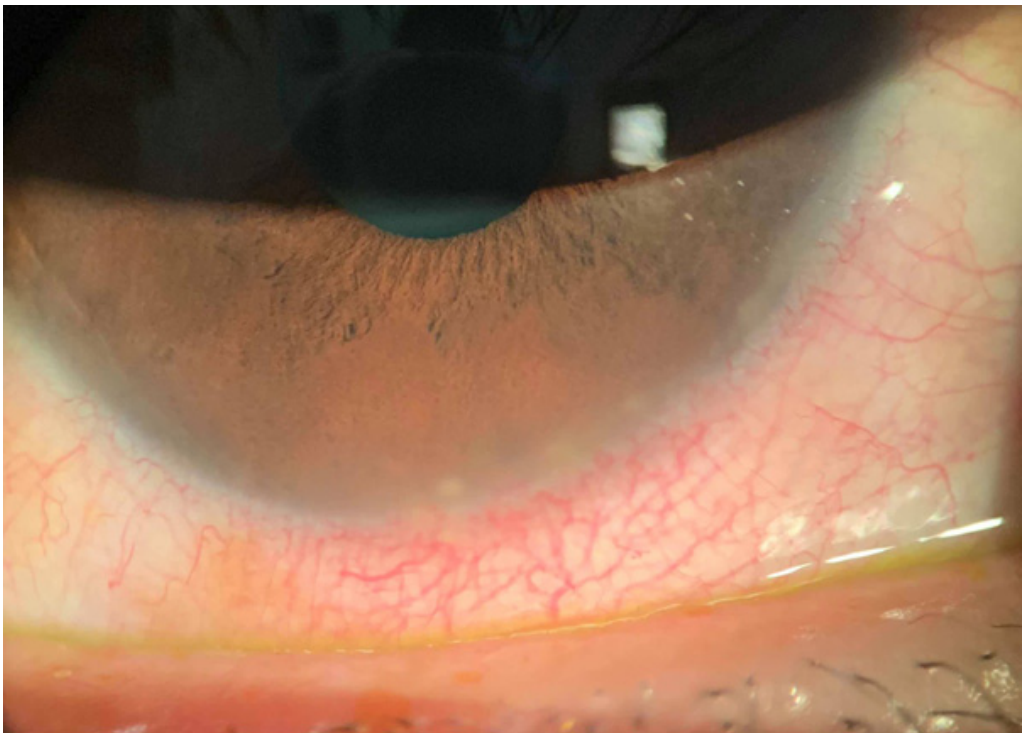

Figure 15. *Peripheral infiltrative keratitis with associated bulbar and limbal injection. Photo: Luis Rojas, 2019*

Signs and symptoms

- Single to multiple small, focal white subepithelial infiltrates
- Irregular in shape with accompanying sectoral or circumferential diffuse infiltrative patterns
- Normally unilateral, located in the mid-periphery and periphery of the cornea

- Overlaying superficial punctate staining to small erosions may be present.
- Bulbar and limbal injection
- Watery to occasional purulent discharge
- Intolerance to acute pain during contact-lens wear
- Minor infiltrates may be asymptomatic
- Not associated with overnight wear of the lenses

Aetiology

Infiltrative keratitis is an infiltrative inflammatory response triggered by a chemotactic stimulus to contact-lens solution preservatives (chlorhexidine or thimerosal), environmental toxins, bacterial exo- and/or endotoxins, tight-fitting contact lenses, denatured protein and contact-lens wear.[131] IK is seen with both daily and extended lens-wear, but is not associated with overnight wear and is seldom reported in the morning.

Differential diagnosis

- Corneal scars
- Other infiltrative events, such as CLARE or CLPU
- Viral infections, such as H. Simplex or H. Zoster
- Microbial keratitis
- *Acanthamoeba keratitis*

Treatment and management

- Remove contact lens until the infiltrate(s) resolves
- Unpreserved artificial tears t.i.d to 10x daily.
- Oral analgesic if required
- Prophylactic antibiotics, e.g. tobramycin q.i.d.

Contact-lens-induced acute red eye (CLARE)

CLARE is a sudden corneal infiltrative event associated with overnight extended wear of contact lenses.[122,132] (Figure 16)

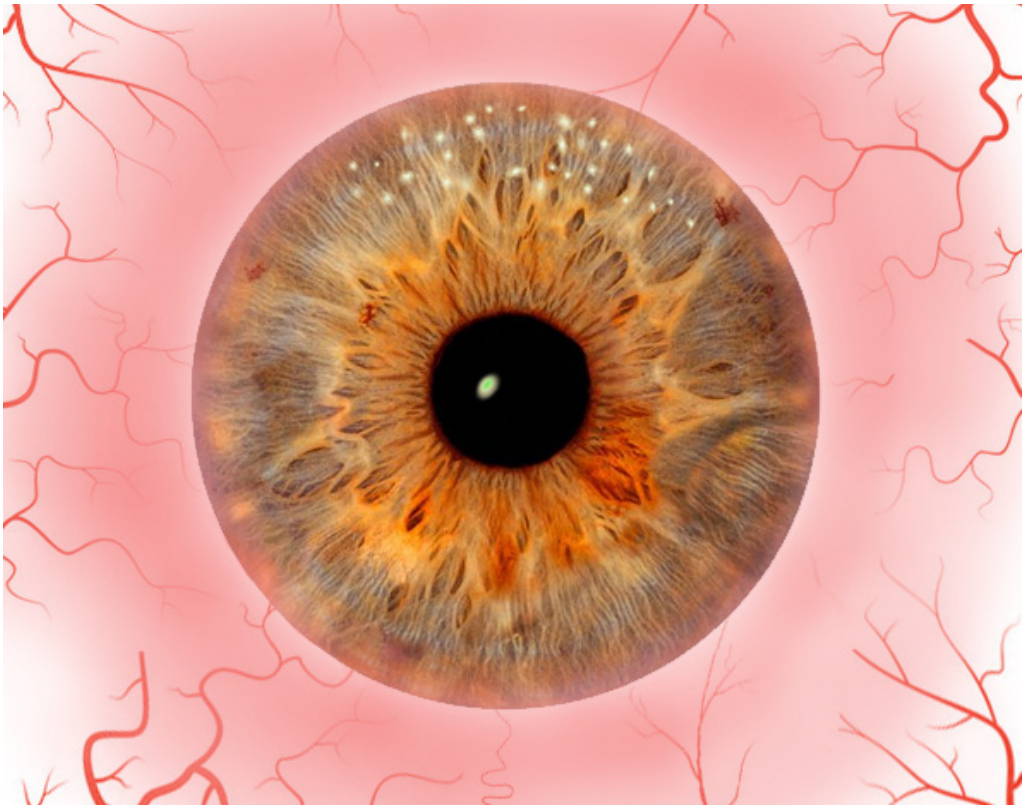

Figure 16. *Contact-lens-induced acute red eye (CLARE) is characterised by early morning acute pain and circumferential hyperaemia coupled with multiple sectoral or circumferential diffuse infiltrates. Image: Roan Laas, 2019*

Signs and symptoms

- Unilateral, early morning acute pain with symptomatic improvement on lens removal.
- Multiple (up to 60) focal epithelial and subepithelial infiltrates.
- Significant sectoral or circumferential diffuse infiltration in mid-peripheral and peripheral cornea.
- Moderate to severe circumlimbal and conjunctival diffuse hyperaemia.
- Photophobia.
- Epiphora (increased tearing).
- No to minimal corneal staining with no correlation to the underlying infiltrates.
- In severe cases, corneal oedema or anterior uveitis.
- Decreased visual acuity in the active stage, recovering to normal when the condition resolves.
- History of recent upper respiratory tract infection or symptoms of the common cold

Aetiology

Contact lenses from CLARE patients are commonly contaminated with Gram-negative bacteria such as *Pseudomonas aeruginosa, Pseudomonas putida, Serratia marcescens*[133-135], and *Haemophilus* influenza.[136]

The inflammatory reaction is in response to the accumulation of toxins and other products released from the Gram-negative bacteria adhering to the contact lens and not the epithelium, combined with the pro-inflammatory state created by the overnight closed eye.[132]

Differential diagnosis

- Viral infections such as H. simplex or H. zoster
- Microbial keratitis
- *Acanthamoeba keratitis*
- Contact-lens-induced peripheral ulcer (CLPU)

Treatment and management

- Cease contact-lens wear and review wearing schedule
- Unpreserved, sterile saline or artificial tears t.i.d to 10x daily.
- Prophylactic antibiotic/steroid combination if disruption of the epithelium is present, e.g. tobramycin and dexamethasone tapered starting with q.i.d.

Contact-lens-induced peripheral ulcer (CLPU)

CLPU is a non-infectious, infiltrative response to bacterial exotoxins and or endotoxins. The event is self-limiting and resolves into a small dense circumscribed scar with no loss in visual acuity.[132] (Figure 17)

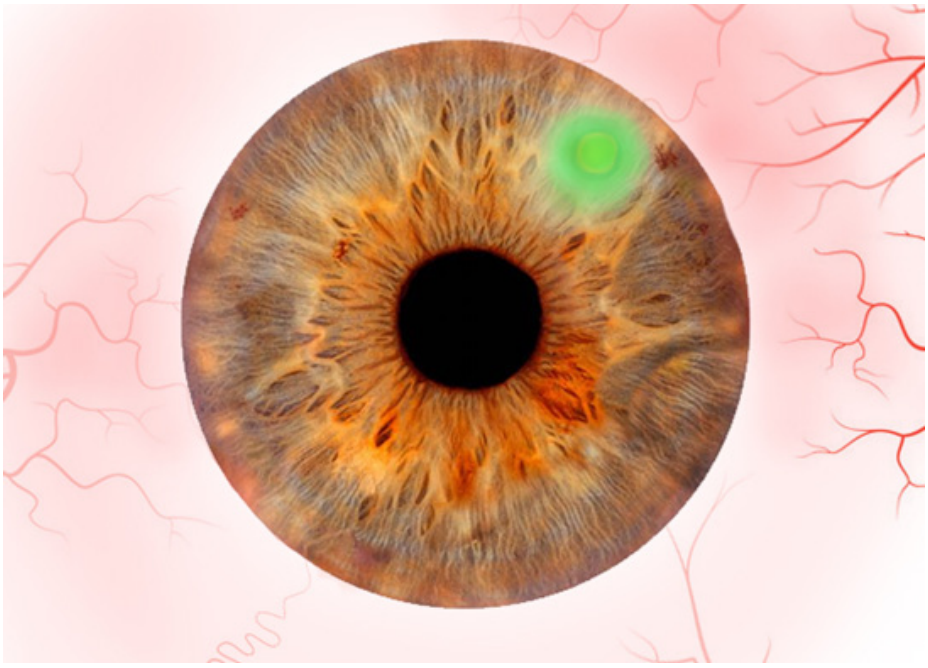

Figure 17. *Contact-lens-induced peripheral ulcer (CLPU) is characterised by a single, round, well-defined infiltrate in the peripheral cornea. Image: Roan Laas, 2019*

Signs and symptoms

- Single, round, well-defined infiltrate towards the periphery of the cornea
- The infiltrate has a clear defined margin, 0.20 mm to 1.00 mm in diameter
- Stemming from the limbal blood vessels, a triangular-shaped, slight to moderate diffuse infiltration surrounding the lesion
- Overlying epithelium abrasion occurs early in the morning.
- Occasionally cells and flare in the anterior chamber
- Foreign body sensation to severe pain which typically reduces on lens removal

Aetiology

Contact-lens-induced peripheral ulceration (CLPU) is a relatively common response associated with wearing of soft contact lenses, especially on an extended-wear schedule. The condition is inflammatory; not infective. Though it is bacteria-related, particularly *Staphylococcus aureus,*[132] bacteria do not invade or replicate in the cornea and there is no progression to infection, nor is the condition a marker for increased risk of microbial keratitis.

Differential diagnosis

- Contact-lens-induced acute red eye (CLARE)
- Viral infections such as H. simplex or H. zoster
- Microbial keratitis
- *Acanthamoeba keratitis*

Treatment and management

- Discontinue lens wear
- Unpreserved, sterile saline or artificial tears, as required
- Typically self-limiting, but in an active stage a prophylactic antibiotic can be prescribed, e.g. tobramycin or moxifloxacin q.i.d. After 48 hours, treatment with topical dexamethasone may be considered after consultation with a corneal ophthalmologist.[137]

Bacterial keratitis

Bacterial keratitis is a sight-threatening ocular, infectious disease which can progress rapidly to corneal opacification. It may be acute or chronic and may involve any part of the cornea.[138] Early diagnosis and prompt treatment is needed to minimise the risk of vision loss.[139-141] (Figures 18, 19 and 20)

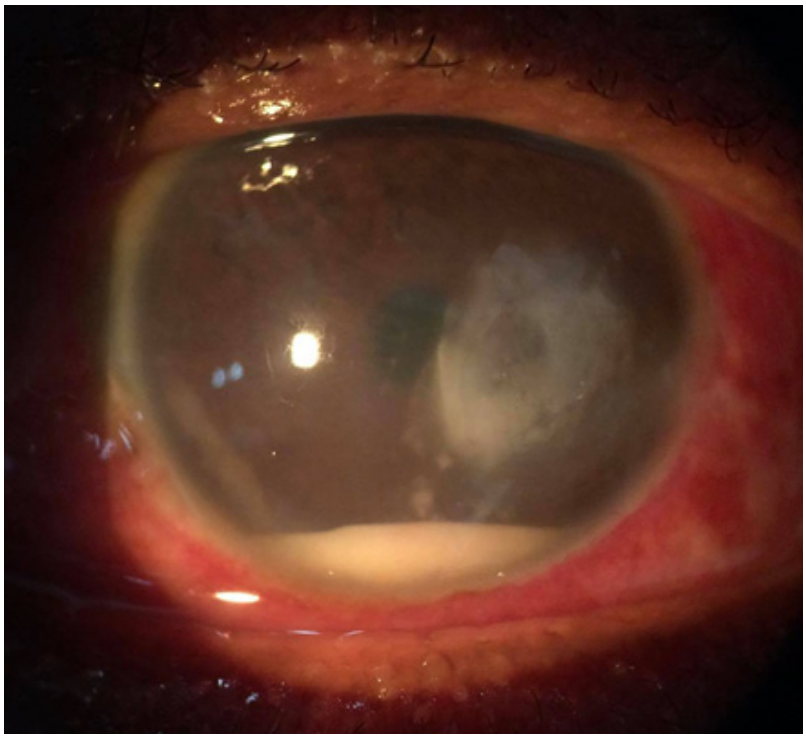

Figure 18. *Diffuse, irregular focal lesion with accompanying hypopyon due to microbial keratitis. Photo: Luis Rojas, 2019*

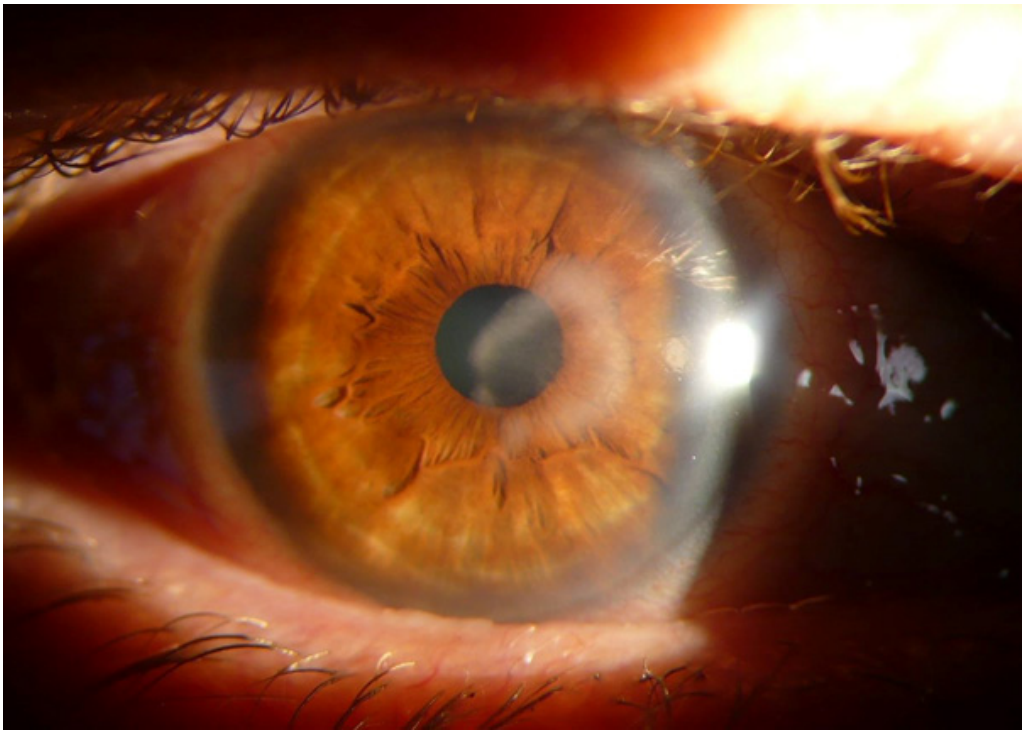

Figure 19. *Central scarring following microbial keratitis. Photo: Hal Ostrom, 2019*

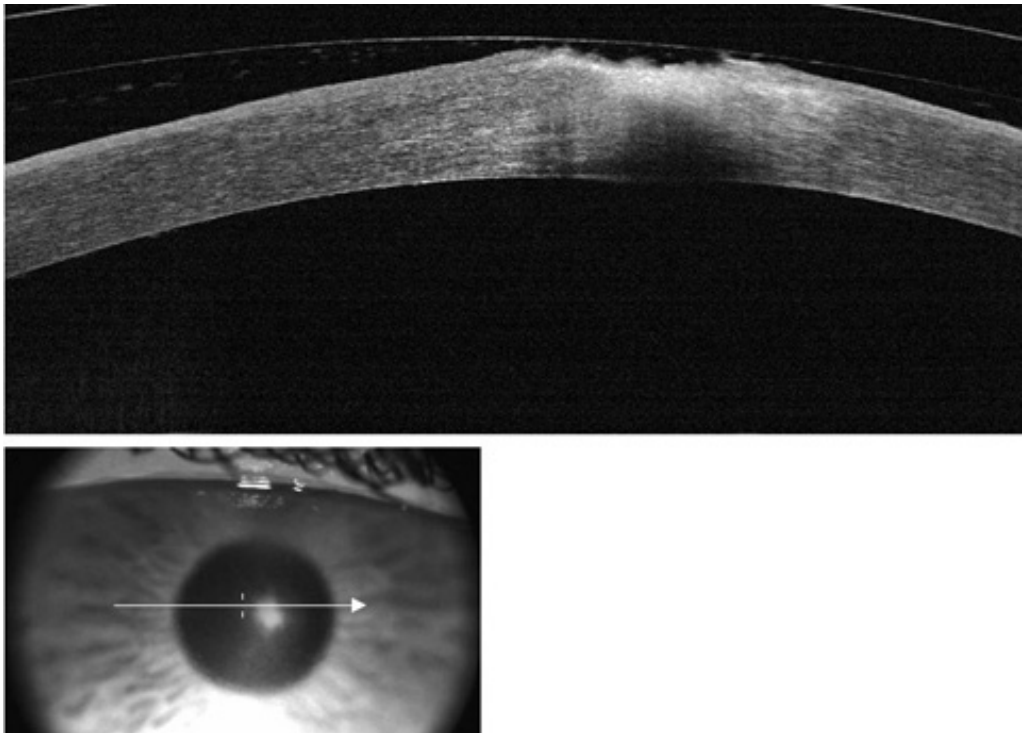

Figure 20. *OCT showing a horizontal cross-section of acute bacterial keratitis under a scleral lens due to patient non-compliance and overwear. Image: Sherrie Esterhuizen, 2017*

Signs and symptoms

- Unilateral, single or diffuse, irregularly-shaped focal lesion.
- Edges of the lesion appear raised due to deepening of the ulcer bed.
- Oedema and significant diffuse infiltration surrounding the epithelial break.
- Mucopurulent or watery discharge.
- Moderate to severe bulbar and limbal hyperaemia.
- Conjunctival chemosis.
- Moderate to severe pain.

- Anterior uveitis with miosis, cells, flare, hypopyon and hypotony (low intra-ocular pressure)
- Photophobia.
- Possible lid oedema and pseudoptosis.

Aetiology

Bacterial keratitis is infectious in nature with the causative agents Gram-positive or Gram-negative bacteria. *Pseudomonas-, Staphylococcus*- and *Streptococcus* species are the most common causative organisms associated with contact-lens-related bacterial keratitis.[142–144] Of the group, *Pseudomonas aeruginosa* is the most opportunistic and virulent pathogen and under compromised ocular conditions[145,146] can bind to the contact-lens surface and damaged epithelial cells,[147] where it can invade and potentially perforate the cornea within 72 hours.[138]

Predisposing factors for bacterial keratitis include occasional overnight and extended wear of contact lenses, smoking, poor hand hygiene, microbial contamination of storage case, young adults, male gender, multipurpose contact-lens solution, internet supply of contact lenses, history of ocular inflammation, trauma and ocular surface dry eye disease.[148–153]

Differential diagnosis

- Viral infections, such as H. simplex or H. zoster
- Fungal keratitis
- *Acanthamoeba keratitis*
- Foreign body
- Corneal infiltrative events, such as CLPU, CLARE and IK
- Abrasion or laceration

Treatment and management

- Cycloplegic drops for comfort and to prevent synechiae formation, e.g. cyclopentolate, phenylephrine or tropicamide

Mild cases (low risk of vision loss) include small, non-staining peripheral infiltrates with minimal anterior chamber reaction and discharge.

- Topical fluoroquinolone, e.g. moxifloxacin q4h

Medium-sized (1 to 1.50 mm diameter) peripheral infiltrates, or small infiltrates with epithelial breaks, mild anterior chamber reaction, or moderate discharge.

- Topical fluoroquinolone, e.g. moxifloxacin, gatifloxacin or ciprofloxacin. Start with doses of 1 drop hourly for two days and then 1 drop 2-hourly

Severe sight-threatening cases

Obtain bacterial cultures from corneal scrapings for any infiltrates larger than 3 mm, infiltrates within the visual axis, infiltrates unresponsive to initial treatment or if an unusual organism is suspected from case history or examination.

- Topical fluoroquinolone, e.g. moxifloxacin 1 drop 1-hourly for two days followed by 1 drop 2-hourly
- Add fortified broad-spectrum antibiotics (5% ceftazidime) hourly if no response
- Topical corticosteroids can be used after 48 hours of treatment if severe inflammation persists and only after the organism is identified and the infection is under control.[137]
- Eyes with corneal thinning should be protected by an eye shield. Do not patch an eye with infection.
- Cease contact-lens wear.
- Oral pain medication.
- For patients with associated scleral infection or impending corneal perforation, add oral fluoroquinolones, e.g. ciprofloxacin 500 mg p.o., q.i.d., or levofloxacin 500 mg p.o, q.i.d.
- Admission to a hospital may be necessary if the condition is sight-threatening, there is a risk of non-compliance or suspected topical anaesthetic abuse or if intravenous antibiotics are needed.

At the first suspicion of microbial keratitis, the patient should be referred to a corneal ophthalmologist as a matter of urgency.

Acanthamoeba keratitis

Acanthamoeba keratitis is a rare but serious complication associated with contact lens exposure to water and poor lens hygiene. The disease carries significant risk, resulting in loss of vision and more severe cases requiring a corneal graft (penetrating keratoplasty) with a potential risk of endophthalmitis leading to enucleation.[154-158] (Figure 21)

In the early stages, acanthamoeba is often misdiagnosed due to a similar presentation as herpes simplex with pseudodendrites.[159,160]

Signs and symptoms

- Initially presents as a central to paracentral local haze.
- Accompanying satellite lesions in the surrounding cornea.
- Stromal ring infiltrate develops as the condition progresses.
- Overlying epithelial defects.
- Dendritic ulcer.
- Perineural infiltrates – infiltrates clustered around corneal nerves, which *Acanthamoeba* is attracted to and destroys.[161]
- Anterior chamber inflammation with cells, flare and hypopyon.
- Limbitis.
- Pseudoptosis.
- Lack of discharge.
- Poor response to antibiotic and antiviral therapy.
- Cultures for bacteria are negative.
- Severe ocular pain out of proportion to signs.
- Prolonged photophobia.
- Long, progressive course of varying intensity.

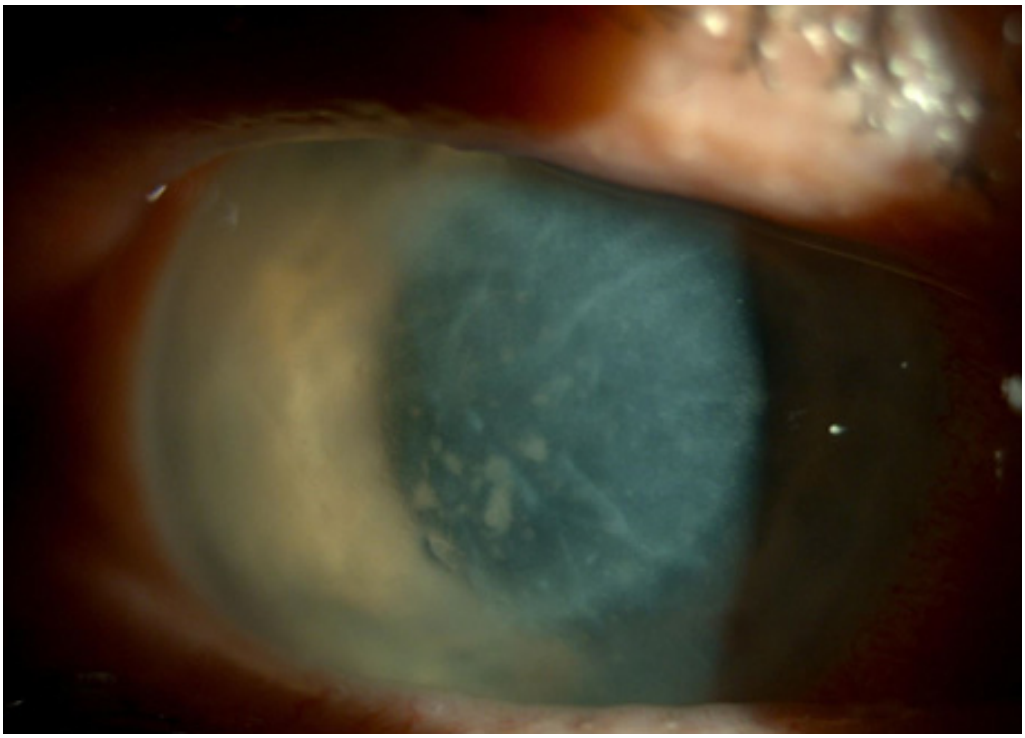

Figure 21. *Active stage of* Acanthamoeba keratitis *presenting with a stromal ring infiltrate, satellite lesions in the surrounding cornea and radial perineural infiltrates. Photo: Carol B Parker*

Aetiology

Acanthamoeba is a ubiquitous, free-living protozoan, occurring in two forms: the first stage motile trophozoites and the second stage non-motile cysts. The double-walled cysts are metabolically dormant and can remain feasible for more than 20 years,[162] surviving in hostile environmental conditions, such as chlorinated swimming pools, Jacuzzi's and in sub-freezing freshwater lakes.[163,164]

Patients rinsing their contact lenses or lens-storage cases with water and those showering or swimming with contact lenses in situ are at high risk for developing *Acanthamoeba keratitis*.[165-167]

Differential diagnosis

- Viral infections such as H. simplex or H. zoster
- Bacterial keratitis
- Fungal keratitis

Treatment and management

- Discontinue contac- lens wear immediately.
- Biguanide monotherapy: hourly PHMB (polyhexamethylbiguanide) 0.02%. Chlorhexidine is an alternative to PHMB if unavailable. Diamidine, e.g. Brolene, may be added, but not used as monotherapy.
- Low-dose topical corticosteroid after the infection is controlled, to reduce inflammation.
- Cycloplegia b.d., e.g. cyclopentolate or phenylephrine.
- Oral nonsteroidal anti-inflammatories.
- Oral analgesics.

At the first suspicion of *Acanthamoeba keratitis*, refer to a corneal ophthalmologist as a matter of urgency. (Figure 22)

Figure 22. *Severe corneal scarring is one of the long-term sequelae of* Acanthamoeba keratitis

Conclusion

Considering the increase in contact-lens popularity, being familiar with the various types of modern-day contact lenses and their indications, has become important in primary health care. When worn, maintained and replaced correctly, wearers can benefit from years of successful and uneventful contact-lens wear.

The advantages of modern contact lenses far outweigh the disadvantages for most wearers in the workplace, as well as at leisure. For some, who would otherwise be visually impaired to the degree of interdependence, contact lenses are a life-changing visual aid.

However, certain contact lens-related risk factors do exist. This article has touched on some of the more common contact lens-related complications medical and eye-care practitioners may encounter. Accurate diagnosis and prompt treatment coupled with proper patient education will influence the rate and degree of recovery and minimise the risk of permanent visual loss or structural damage.

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CONTACT LENSES: CPD Questions

1. Soft contact lenses can provide adequate vision for most refractive errors, including:
   a. Severe myopia
   b. Acute astigmatism
   c. Presbyopia
   d. None of the above

2. A severe corneal irregularity, such as advanced keratoconus, is best corrected with:
   a. Spectacles
   b. Soft contact lenses
   c. Rigid contact lenses
   d. Cannot be corrected

3. Hybrid lenses are indicated for regular refractive errors, as well as for irregular corneas, when corneal GP lenses cannot be tolerated due to ……. and …….
   a. Poor centration
   b. Discomfort
   c. Poor vision
   d. Poor oxygen transmissibility

4. Which of the following statements are correct regarding the advantages of scleral contact lenses?
   a. The liquid-filled layer between the cornea and the lens acts as a liquid bandage in corneal surface diseases, such as Stevens-Johnson syndrome.
   b. Offer the crisp visual optics of a rigid lens, while the soft skirting aids lens centration, provides good initial comfort, and prevents debris getting trapped beneath the lens
   c. Provide a safe and successful option for vision correction where other contact lenses and medical treatments fail
   d. May neutralise corneal irregularities in conditions such as astigmatism

5. Which statements are correct regarding the advantages of children wearing contact lenses?
   a. Ametropic children rate a marked improvement in their self-confidence regarding appearance, social acceptance and participation in sporting activities when wearing contact lenses.
   b. The progression of myopia in children may be slowed down with orthokeratology lenses.
   c. The risk to ocular health in children wearing contact lenses is no higher than in adults.

6. Which of the following are risk factors for developing contact lens-related complications?
   a. Blepharitis
   b. Poor hygiene
   c. Being female
   d. Wearing soft lenses past their replacement date

7. Giant papillary conjunctivitis (GPC) has a cobblestone appearance with a diameter larger than 0.50 mm.
   a. True
   b. False

8. Abrasion caused by fingernail scratching when inserting and removing lenses can lead to contact lens-related superficial punctate screening.
   a. True
   b. False

9. Which of the following is NOT a sign/symptom of asymptomatic infiltrative keratitis?
    a. Uni-or bilateral
    b. A low number (<2) of small (<0.20 mm diameter), focal and/or diffuse infiltrates
    c. Punctate staining
    d. Slight- to moderate conjunctival hyperaemia

10. CLARE is an infectious, infiltrative response to bacterial exotoxins and/or endotoxins.
    a. True
    b. False

11. Bacterial keratitis is a sight-threatening ocular infectious disease which can progress rapidly to corneal opacification. Early diagnosis and prompt treatment is needed to minimise the risk of vision loss.
    a. True
    b. False

12. Which of the following are signs and/or symptoms of *Acanthamoeba keratitis*?
    a. Severe ocular pain out of proportion to signs
    b. Significant discharge
    c. Stromal ring infiltrate develops as the condition progresses
    d. Perineural infiltrates