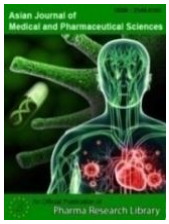

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Causes and Awareness on Contact Lens to Prevent Opportunistic Infections

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A B S T R A C T

Contact lenses for visual correction offer many benefits to the 4 million wearers in the UK, yet contact lens-related microbial keratitis is a frequent cause of unilateral visual impairment. Severe cases can result in permanent vision loss, a need for corneal transplant or loss of the eye. In all healthcare systems, contact lens-related microbial keratitis poses a significant healthcare challenge as patients require intensive topical antimicrobial therapy and close monitoring of treatment response. It is typical for contact lens storage containers to have persistent microbial contamination, which has been linked to microbial keratitis and clear corneal invasion. Contact lens-associated microbial keratitis is an interesting, potentially sight-threatening complexity arising from wearing soft contact lenses. Estimates show that for every 10,000 persons who wear contact lenses each year, there are 2 to 5 occurrences of microbial keratitis. Investigating separate determinants for contact lens-associated MK and evaluating their impact on infection load is one of the challenges in their administration. It is hoped that this will offer a useful outline of the complicated issues of contact lens wear that are both infectious and non-infectious. Recent epidemiological studies detailing the risk factors associated with contact lens use, and the effect of pathogen and individual immune profiles on the severity of diseases have enlightened how we might interpret the prophylaxis and prevention of contact lens-related corneal infection. Safe contact lenses are an effective form of vision correction for the millions of people who require them; however, they are not devoid of risks. The risk of eye infection increases due to a lack of care and personal cleanliness such as topping off storage cases with disinfection solution and washing contact lenses in fresh water. It is uncommon in this demographic to use contacts for prolonged periods or a greater variety of activities. Since contact lens technology has advanced, individuals who prefer not to wear glasses frequently select this method of vision correction.

Keywords: Contact lenses, microbial keratitis, vision correction, eye infection, sight-threatening complexity.

A R T I C L E I N F O

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C O N T E N T S

1. Introduction

Contact lens (CL) use has increased tremendously owing to different indications and varied benefits. The common indications of contact lenses are cosmetic, therapeutic, treatment of refractive error, and correction and control of myopia. There are approximately 140 million contact lens users globally, which is ever-increasing. Many different types of contact lenses are available in the market to give every patient a spectacle-free life. Contact lenses act as a foreign body over the ocular surface and, despite their numerous benefits, are known to cause many complications. With improvements in contact lens technology and continued research, the contact lens market

has multiplied manifolds. Healthcare workers prescribing contact lenses must keep themselves updated regarding the benefits and problems associated with contact lenses. The complications can be broadly classified as infective and non-infective and conjunctival and corneal complications. The various corneal complications are epithelial edema, microcysts, abrasions, superficial punctate keratitis, contact lens-related peripheral ulceration, peripheral corneal staining, sterile corneal infiltrates, corneal neovascularization, microbial keratitis, bacterial keratitis, fungal keratitis, acanthamoeba keratitis, warpage, and endothelial changes[1-5].

The conjunctival complications include allergic conjunctivitis, giant papillary conjunctivitis, and superior limbic keratoconjunctivitis. The other listed complications can be physical damage to the lens and discoloration. CL-related complications have decreased with CL materials, manufacturing techniques, and ocular hygiene advances. This activity focuses on various problems and complications associated with contact lenses and the necessary interventions to safeguard the patient from irreversible changes.

2. Function

Tear and Contact Lens Interaction

The corneal tear film plays a vital role in maintaining the functional integrity of the cornea. It acts as a barrier, nourishes, and lubricates the corneal surface. The cornea is the primary refractive surface and comprises numerous refractive elements. It is vital to maintain the transparency and integrity of the cornea. The contact lens acts as a barrier between the tear film and the cornea and hampers the harmonious relationship between the two. This interaction reduces contact lenses' health, functioning, efficiency, efficacy, and acceptability.

Lens Position and Tear Film Interaction

The lens can't be clamped or stuck to the cornea. The properties of the tear film, such as surface tension and viscosity, act as glue to hold the contact lens over the cornea surface. Once the lens is inserted inside the eye, the conjunctival mucus rubs against the lens surface with several blinks, and tear fluid helps to wet the lens. The tear fluid spreads all over the lens surface, including the periphery, and helps to stick the lens to the surface.

The pre-lens tear film acts as a plastic sheet to hold and tack the lens due to the firm, cohesive force between the water molecules and also serves as an adhesive force between water and the lens material. Approximately 11grams of force is needed to displace the lens as per experimental studies. When the tear film covering the lens breaks, the method of internal adhesion plays a key role. Negative pressure builds up between the lens, the corneal surface, and the tear film. It acts as a collar between the edge of the lens and the cornea, and this tear film acts as a container for the lens. When measured, this negative pressure is approximately 29 dynes/ cm.

Optical Properties

The tear lens or the post-lens tear film interface plays an essential role in improving the function of the contact lens. The irregularities on the corneal surface are filled by the back of the tear lens film, thus forming a uniform optical surface, and the front surface of the tear lens is shaped by the rear surface of the contact lens. The refractive index of the cornea is 1.376, and that of tears is 1.337. If the indices were equal, all degrees of the irregularities of the corneal surface, as well as astigmatism, would be perfectly corrected with the CL. With high degrees of astigmatism, residual astigmatism will be proportionately higher.

Impact on Corneal Nourishment

- Contact lens impacts the cornea in numerous ways.
- Retard the tear evaporation and interfere with tear hypertonicity.
- Acts as a barrier to the delivery of oxygen
- Traps the water and reduces waste disposal
- Injure or traumatize the dead epithelial cells.

The hard CL covers approximately 50-80% of the corneal surface, and 70 to 85% of this area is permanently protected with normal lens mobility. The covered area is dependent on the nutrition of the tear film under the contact lens. The post-lens tear interface needs constant renewal to meet the corneal oxygen demands. It has been observed that under static conditions, the oxygen in the post-lens tear interface is exhausted within 90 seconds with hard or soft CL with 40% hydration. Further, the non-oxygen dependant pathway is significantly less efficient (approximately 1/18) than the oxygen-dependent pathway. There is an accumulation of lactic acid, the corneal nutrition is compromised, and this is corneal edema and haziness. The blinking mechanism creates a pump mechanism in the cornea-contact lens interface, and the pressure on the lid presses the contact lens, which expels the post-lens tear interface, which is then formed again. The pump efficacy depends upon

Tear volume behind the contact lens

Blink frequency

Percentage exchange of fluid with each blink

The soft contact lens has a large diameter and comprehensively covers the lens surface. An aqualung effect is seen due to the hydrophilic nature of the lens. When blinking is absent, the corneal surface lacks oxygen, and the pump effect is missing. The oxygen delivery in soft lenses is only 10% of hard CL. But the lens flexibility helps create a capillary layer of fluid under the lens surface. The corneal deturgescence is reduced due to hypotonicity of the tear film resulting from excessive secretion of tears, change in blink rate, and impairment of evaporation.

Lens Edge Effect: The contact lens is covered by the patient's tear film, resulting in a prism-shaped meniscus at the lens edge. If the edge of the lens comes in the pupillary area, it may result in the formation of the second focus of the image on the retina. This is common with low riding as well as high-riding lenses. This is called as ghost image effect or the edge flare effect.

Lens Damage

The lens spoilage can result from irregular contact lens interactions with the tear film. There can be multiple deposits on the contact lens surface which can affect the lens's optical properties. The deposits can damage the contact lens and reduce its working efficiency within six months.

Lens surface irregularities due to manufacturing defects

- Tear film inadequacy
- The porosity of the lens
- Blink irregularity and deficiency
- Immediate tear film break-up time
- Altered tear film composition
- Reduced tear film volume
- Altered pH of the tear film
- Issues of Concern
- Corneal Complications
- Epithelial Complications
- Epithelial Edema

Microcysts

It occurs due to a decrease in corneal metabolism over a long period. They are seen most commonly with soft CL or extended wear contact lenses. These appear as small dots over the cornea of varying density and may mimic Cogan's microcystic dystrophy. These dots clear once the lens is removed. It is advised for these patients to switch from extended wear to daily wear or daily wear to gas-permeable lenses.

Abrasions

These are caused by trauma or mechanical injury due to the lens or while insertion or removal of the lens. A foreign body embedded in the lens can also induce corneal abrasions. The patients usually present with pain, redness, and watering, and the abrasions can be delineated on staining. The best treatment is contact lens removal and a course of topical antibiotics. Patching should be avoided in these cases due to fear of the eye getting infected. Once the infection resolves, contact lens wear can be initiated slowly.

Superficial Punctate Keratitis

Superficial Punctate Keratitis (SPKs) occurs due to mechanical injury from the lens or during lens application. Contact lens-induced chemical toxicity also results in SPK. This occurs secondary to preservatives present in the saline, not being able to clean the lens properly after using surfactant or enzyme cleansers, or failure to clean or neutralize hydrogen peroxide disinfectants. The associated ocular pathologies like dry eyes and blepharitis can also cause SPKs. Patients with SPK have to stop the lenses until the lesions resolve. The topical antibiotics, lubricating eye drops, and ointments also promote healing. The patient should be reassessed before deciding on CL wear again.

Staining at 3 and 9 o Clock

This occurs due to corneal desiccation because of interruption of tear film or reduction of tear film at the nasal and temporal limbus. The main risk factors are poor lens edge tilt, limited lens movement, low riding lens, poor blink rate, presence of pinguecula, and adherence to the lens surface. It occurs most commonly in RGP lenses.

Sterile Infiltrates

These are due to an inflammatory response to a particular antigen with associated corneal leucocyte infiltration from the adjacent limbal vessels. The preservatives present in the contact lens cleaning solution are implicated as the major source of antigens. These appear as small opacities, which can be epithelial, subepithelial, or anterior stroma. These infiltrate do not cause any symptoms and are detected on a routine examination. In some cases, a corneal infiltrate is an early indicator of microbial keratitis. The infiltrate disappears once the contact lens is discontinued. Once the infiltrate resolves, the patient can start wearing the CL with a preservative-free saline solution.

Peripheral Corneal Ulceration

These ulcers are characterized by epithelial infiltration with an intact Bowman layer. The clinical presentation is different from that of microbial keratitis. The peripheral corneal ulcers involve the paralimbal area and are white, crescentic to oval excavated ulcers and may be associated with thinning. There is mild congestion and focal infiltrates in contrast to microbial keratitis, which usually affects the visual axis and is characterized by epithelial defect and stromal melt. Peripheral corneal ulceration is also called marginal keratitis, and the primary causative agent is staphylococcal toxins[6-15].

Corneal Neovascularization

This results from excessive hypoxia due to prolonged lens wear or a tight or thicker lens. Neovascularization can be superficial, deep, sectoral, or involve 360 degrees of the cornea. In extended wear contact or therapeutic CL, a small amount of peripheral superficial vascularization is common (1 to 2 mm). A growth having a progression of more than 2 mm or involving a middle or deeper stroma is not common. Careful fitting of CL, regular follow-up of patients, and use of high oxygen transmission lenses with discontinuation of older ones is the treatment for neovascularization.

Microbial (Infective) Keratitis

This is also known as contact lens-induced keratitis (CLIK). It is one of the serious complications but not a very common complication of contact lens wear. It may occur with any type of contact lens wear but is more common with soft CL and more familiar with extended wear CL. It starts with an epithelial defect secondary to trauma or hypoxic associated with microbial contamination. The significant risk factors are poor personal hygiene, inadequate lens cleaning, contamination of lens cover or lens cleaning solution, and the presence of dry eyes and blepharitis. The common organisms involved are Pseudomonas aeruginosa and Acanthamoeba. The other microorganisms, such as gram-negative and gram-positive bacteria, can also cause CL-induced keratitis.

Acanthamoeba Castellani Infection

This condition is more common in patients using homemade saline for lenses, swimming in a swimming pool with CL, swimming in contaminated water, and exposure to tub and tap water. The most common clinical features are a pain out of proportion to clinical findings, irregularity of epithelium, and patchy stromal infiltrate. The late clinical features include stromal infiltrate, radial keratoneuritis, and elevated linear epithelial lines. Precautions must be taken to prevent this problem in patients. Prolonged lens wear, primarily sleeping with CL on, is a significant risk factor for acanthamoeba keratitis. Good ocular hygiene with regular cleaning and disinfection are the critical factors in preventing corneal ulcers in these patients. The patient should be explained in detail the risk factors and warning signs of corneal infection to avoid this ocular catastrophe. Once the corneal ulcer has occurred, it should be dealt with very early and meticulously.

Pseudomonas Aeruginosa Keratitis

Pseudomonas is the most common cause of microbial keratitis in patients using CL. The patient usually presents with pain, redness, and discharge out of proportion and size of the infiltrate. The clinical findings are the presence of corneal infiltrate, ring infiltrates, and the presence of hypopyon in advanced cases.

Fungal Keratitis

Another sight-threatening complication associated with CL is fungal keratitis, characterized by dense gray-white stromal infiltrate, feathery margins, satellite lesions, endothelial exudate, and hypopyon. The diagnosis is by the corneal scraping of the infiltrate, and smearing and culture will pinpoint the microorganism. The incidence of fungal keratitis secondary to CL wear varies from 10 to 21%. The most common causative agents are *Aspergillus*, *Fusarium*, and *Candida*. CL wear is the major cause of yeast-like fungal keratitis[16-25].

Extended-wear lenses are associated with an increased risk of CL keratitis, followed by hydrogel and rigid gas-permeable contact lenses. Trauma with vegetative matter is the major cause, and topical antifungals are the mainstay of treatment. The commonly used antifungals are 5% Natamycin, 0.3% Amphotericin B, 1% voriconazole, 1% Itraconazole, and 1% Itraconazole. Non-resolving cases will require therapeutic keratoplasty.

Prolonged contact lens wear can induce severe and permanent astigmatism in the eyes in response to chronic hypoxia. The corneal shape changes temporarily due to prolonged use of impermeable hard CL. The warpage is usually detected on corneal topography and reverses with the discontinuation of CL. It can also cause a temporary reduction in visual acuity. The other complications with contact lenses can be foreign body tract formation, corneal Dellen, vacuoles, mucin ball formation, and dimple veiling.
Corneal Endothelial Changes. Contact lens wearers can have both short-term and long-term endothelial changes. The endothelial changes are thought to occur secondary to hypoxia which causes lactic acid accumulation in the cornea, elevated levels of carbon dioxide, and reduced pH.

Two types of changes are seen clinically

Endothelial bleb response

This is thought to occur minutes after using a thick, soft, or rigid contact lens. This is a transient effect and doesn't produce other side effects. The bleb changes usually resolve after 30 minutes of lens application or rapidly after lens discontinuation.

Endothelial Polymegathism and Pleomorphism

These changes are noticed after a long time of contact lens wear. These changes are associated with corneal decompensation following intraocular surgery. These changes can be reduced by promoting the use of daily wear CL over extended-wear lenses and the use of RGP lenses over rigid PMMA lenses.

Contact Lens-Related Discomfort

Per the Tear Film and Ocular Surface Society, discomfort associated with CL is characterized by occasional or regular adverse eye sensations associated with lens application, which may or may not be associated with visual discomfort, secondary to reduced harmony between the CL and surrounding ocular surface environment. This results in reduced usage or discontinuation of CL. The CL factors associated with discomfort are lens material, design, wearing time, hygiene, and fit to the ocular surface. The environmental factors are ocular surface changes, occupation, external temperature, humidity, associated medication use, and compliance. The goal of management is to reduce patient discomfort and modify the associated factors to provide a comfortable daily wear time[26-35].

Conjunctival Complications

Allergic Conjunctivitis: This common complication has been reported with thiomersal-containing solutions. The patient presents with pain, redness, itching, and burning sensations. The reaction usually develops after days to months following exposure to thiomersal. The examination reveals conjunctival hyperemia and the papillary response of the conjunctiva. Avoidance of thiomersal is the best treatment, and steroid eye drops should be used in tapering doses to prevent this reaction.

Giant Papillary Conjunctivitis

This is an immunological complication in which the contact lens deposits and proteins act as an allergic stimulus. The main risk factors for GPC include patient susceptibility, contact lens wear schedule, contact lens care regimen, lens material, and design. GPC is known to occur more commonly after soft CL. Patients with asthma, hay fever, and animal allergy are more susceptible. The most common symptoms are itching, redness, increased mucus production, photophobia, irritation, and reduction in lens tolerance. The upper palpebral conjunctiva show giant cobblestone papillae. The GPC can be reduced by avoiding contact lens use, regular use of enzyme cleanser, change of lenses, avoiding heat disinfectants, and avoiding the use of CL with CL on. The lens should be avoided for at least 1 to 2 months, and treating the patients with sodium cromoglycate and steroid eye drops. Once the condition subsides, newer lenses may be fitted to avoid the recurrence.

Superior Limbic Keratoconjunctivitis

Superior limbic keratoconjunctivitis is a hypersensitivity reaction to thiomersal or preservatives in contact lens solution. SLK is usually bilateral and asymmetric. The patients typically present with pain, redness, foreign body sensation, and contact lens intolerance. The anterior segment findings usually reveal inflammation and hypertrophy of superior bulbar conjunctiva that stain with Rose Bengal stain, punctate epithelial erosions, microphones of the superior cornea, and papillary hypertrophy of superior tarsal conjunctiva. The CL should be discontinued, and lubricating eyedrops should be used frequently. When the pathology resolves, the patient should be given a new pair of contact lenses and must be advised to use non-preserved saline and perform frequent lens cleaning[36-40]. 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 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. 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.

3. 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. 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 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.

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. 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. 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 be controlled. 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.

Prevalence

It is reported that 10–30% of patients diagnosed with corneal neovascularization wear contact lens while corneal neovascularization develops in 1-20% of contact lens users. Patients who use rigid gas permeable (RGP) or poly-methyl methacrylate (PMMA) lenses have a lower rate of neovascularization.

Risk factors

Intrinsic lens parameters including material properties (oxygen transmissibility) have an impact on the development of corneal neovascularization. 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. As the available base curves for soft contact lenses is limited, the problem of poor lens fittingis not surprising. 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; 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. 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. 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. Laser photocoagulation of new vessels, photodynamic therapy, electrocoagulation, and stem cell transplant are surgical interventions recommended in severe cases.

Contact Lens-related Keratitis: 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.

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., reports from 1999.

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. 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.

Acanthamoeba Keratitis

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

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. 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. 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. 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. 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. 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. 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). 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.

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. Considering the presence of a cyst form in acanthamoeba, which is totally resistant to therapy, a combined therapy is advisable. Chlorhexidine and PHMB are considered the most effective drugs for treating AK infections; especially when combined, they are effective against both cysts and trophozoites. 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:

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

Incidence

In some countries such as India and Nepal, fungal keratitis are the majority of microbial keratitis. In 21% of the patients with fungal keratitis, contact lens wear has been documented; whereas this rate was reported to be 10% elsewhere. Fungal pathogens have been found in up to 4.8% of contact lens associated keratitis.

A worldwide outbreak of fungal keratitis in 2006 has been associated with the solution, ReNuMoistureLoc. 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.

Risk factors

Contact lens wear was the leading risk factor for the fungal keratitis, particularly those caused by yeast-like fungi. Moreover, extended wear schedules increase this risk. 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.

Management

Topical medications commonly used in fungal keratitis include natamycin (5%), amphotericin B (0.15–0.30%), topical voriconazole (1%), and miconazole (1%).(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.

Giant Papillary Conjunctivitis

Giant papillary conjunctivitis, also referred to as contact lens-induced papillary conjunctivitis (CLPC), is one of the most common contact lens-related adverse effects.[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.

Incidence

A CLPC incidence rate of 1.5%] to 47.5% has been reported, with an incidence of 4.6% for wearers of first generation silicone hydrogels. The prevalence of CLPC is higher in patients using silicone hydrogel lenses compared with those wearing hydrogel lenses, probably as a consequence of greater mechanical irritation caused by relatively high modulus silicone hydrogel lenses

Risk factors

CLPC has been associated with certain lens types and lens materials, and is seen more often with soft contact lenses (85%) compared with rigid contact lenses (15%), Mechanical trauma may play a role in the etiology of this complication.

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 symptomatic and recurrent events.

Superior Epithelial Arcuate Lesion

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.

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.

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%).

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.

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. 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. 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.

4. Conclusion

The safe contact lenses are an effective form of vision correction for the millions of people who require them; however, they are not devoid of risks[41-42]. The risk of eye infection increases due to a lack of care and personal cleanliness such as topping off storage cases with disinfection solution and washing contact lenses in fresh water. It is uncommon in this demographic to use contacts for prolonged periods or a greater variety of activities. Since contact lens technology has advanced, individuals who prefer not to wear glasses frequently select this method of vision correction. To be able to intervene as necessary, eye care practitioners must be fully aware of the variety of potential problems that lens wearers may encounter. Poor hand hygiene, wearing contacts accidentally at night, and the method of lens maintenance are all free risk factors for microbial keratitis linked to contact lenses. Prevention efforts could include vigorous health promotion activities that increased awareness about the importance of proper contact lens hygiene that can encourage contact lens wearers to adopt healthy habits, such as keeping all water away from contact lenses, discarding used disinfecting solutions from the case, and cleaning with fresh solution each day, and replacing their contact lens case every three months, can reduce their chances of getting an eye infection.

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