Acanthamoeba Infection In Contact Lens Users

***Dr Madhusmita Das**, 1st yr PG, SCB MCH*
*GUIDE: Prof & HOD **Dr S.Mohapatra**, Prof Dr I.Rath **Prof Dr P.K.Nanda***

Introduction

Acanthamoeba is a ubiquitous pathogen that can be found worldwide with different incidence rates, showing the ability to survive in very harsh environmental circumstances. Acanthamoeba keratitis is a potentially blinding corneal infection that may aggressively affect both eyes with the possibility to recur after penetrating keratoplasty. Contact lens wear remains the main risk factor in transmitting Acanthamoeba trophozoites and cysts to the cornea.A 7-year 1997-2003 survey showed an increase in the number of hospitalised patients due to contact lens-related corneal ulcers, which correlated with the increase in the number of lens wearers. Acanthamoeba has a great affinity for the attachment to the corneal epithelium and to contact lenses.

The tendency for Acanthamoeba to adhere to surfaces is a key first step in the pathogenesis of Acanthamoeba keratitis, particularly in contact lens wearers. Contact lenses affect corneal epithelium integrity in two different ways: directly, through the associated fitting-related abrasions and indirectly, by altering the normal physiological and metabolic cellular activities. These later changes render the epithelial cells in a hypoxic status that eventually alters their integrity. Corneal oxygenation is significantly reduced during contact lens overwear, particularly for those who sleep in their lenses overnight. However, patient's compliance and some basic hygienic standards can effectively minimise the risk of Acanthamoeba keratitis.

Contact Lens Related Problems:

Contact Lens-Induced Trauma:

Direct Traumatic effects of lens: The corneal epithelium, with its tight junctions, creates an important barrier against Acanthamoeba invasion to the underlying corneal structures. Corneal epithelial cells are more resistant to the cytopathic effect of Acanthamoeba trophozoites than keratocytes. Contact lens wear cause minor corneal abrasions, which is the key initial step for Acanthamoeba infection.

Corneal epithelial defects make it possible for the Acanthamoeba protozoon to attach to the epithelium and to subsequently invade the rest of the underlying stromal layers. The adhesion of the Acanthamoeba to the corneal epithelial cells is the result of mutual interaction between corresponding mannose-binding glycoproteins on the adjacent surface membranes. Sugar inhibition assays revealed how Acanthamoeba can selectively bind with high affinity to mannose saccharides and not to non-mannosylated neoglycoproteins, such as galactose, fucose, galactosamine or lactose. The corneal surface mannose receptors stimulate Acanthamoeba to secrete pathogenic proteases which, in turn, induce epithelium apoptosis and facilitate amoeba invasion to the underlying stroma.

Indirect effects by contact lenses:persons using contact lenses having low oxygen transmissibility. Carbon dioxide accumulation alters the normal metabolic pathways, which leads to a series of micro-structural changes affecting all corneal layers, such as epithelial microcysts, depletion of epithelial glycogen storage, lactic acid accumulation, corneal acidosis, epithelial oedema, decreased mitotic rate, increased central corneal thinning, corneal hypoesthesia, compromised junctional integrity, increased epithelial cells permeability, increased cellular epithelial fragility, epithelial punctation, microscopic abrasion, sloughing of the epithelium and, eventually, corneal ulceration. In addition, changes in tear film thickness and stability and alteration of the normal profile of conjunctival commensal have been recognised. All these changes collectively breach the natural extra ocular protective mechanisms, rendering the cornea an easy target to a wide array of pathogens, including the Acanthamoeba.

Attachment of Acanthamoeba to Contact Lenses

Contact lenses serve as a vehicle for the harbouring, transmission and delivery of microorganisms to the eye. The ability of Acanthamoeba to attach to contact lenses is influenced by several factors:

Contact Lens Material, Ionicity, and Water Content.

The manufacturing material affects contact lens ability as a mechanical host allowing attachment and transfer of Acanthamoeba trophozoites or cysts onto the corneal surface. The incidence of Acanthamoeba is much lower with rigid lenses, as compared with the soft type. Rigid gas-permeable lenses were recommended to hospital staff members wearing lenses, with the aim of minimising the risk of infectious keratitis, due to the easy removal of the attached Acanthamoeba trophozoites and cysts from the surface of this type of contact lenses.

The greater affinity of Acanthamoeba trophozoites for silicone hydrogel lenses, as compared with conventional hydrogel lenses ($P<0.001$) was attributed to the attachment characteristics of the polymer of silicon type. The attachment of Acanthamoeba trophozoites to different soft contact lens materials, such as polymacon, etafilcon A, lidofilcon A, and bufilcon A varied significantly, with the greatest adherence being observed for lidofilcon A and the least for the etafilcon A lenses. Adherence of cysts and trophozoites was found to be higher for the non-ionic than for the ionic disposable lenses.It is suggested that the attachment of Acanthamoeba was highly dependant on the ionic nature and the water content of soft contact lenses. Collectively, these reasons could explain why Acanthamoeba adherence is higher for disposable and extended-wear soft lenses than for the conventional soft daily and rigid lenses.

Duration of exposure:

Acanthamoeba adherence to lens surface increased significantly for longer exposure durations and for higher concentrations of inoculum.

Acanthamoeba-Life Stage: Acanthamoeba trophozoite shows a greater tendency to adhere to contact lenses, as compared with the cystic form.

Lens Surface Deposits:

Attachment of trophozoites and cysts to contact lenses is highly influenced by the presence of protein deposits on the lens surface. Protein deposits on contact lens surface increase the adhesion of other bacterial microbes like Pseudomonas aeruginosa, on which Acanthamoeba feeds. Protein and lipid deposition on lens surface is mediated by the chemical structure of the lens material and its water content. The high water content and the ionic material of some disposable soft lenses allow for more deposition of proteins, a fact that could explain the greater affinity of the Acanthamoeba protozoon for worn lenses than for unworn ones. Jones et al. reported significant deposition of low levels of lysozyme and high levels of lipid on silicone hydrogel contact lens materials, as compared with ionic contact lens materials. The adhesion of Acanthamoeba in unwashed worn versus unwashed unworn contact lenses showed a significantly lower adherence of Acanthamoeba to new lenses. The serine protease subtilisin A enzyme used for protein removal from contact lenses has been found to have no cysticidal action even after 24 hours of exposure. However, it could lower the number of protozoa attached to lens surface through protein removal.

Mechanical care in contact lens users:

While shaking showed no significant effect on adherence, a post-incubation wash using phosphate buffered saline decreased the number of adherent cysts and trophozoites.

Several studies suggested that a good wash significantly decreased the adherence of trophozoites and cysts to the contact lens surface, though one study suggested that washing had no effect on either Acanthamoeba stage. Rinsing contact lenses in saline using the flow method was significantly more effective than the immersion technique in removing adherent Acanthamoeba trophozoites from rigid gas-permeable lenses. Recent studies, showed that multipurpose contact lens solutions that employed a manual rub regime were more effective in removing adherent looselybound deposits and different pathogenic microbes from soft hydrogel lenses than rinsing or soaking alone.

Associated bacterial infection:

The contamination of lens care systems with bacteria is an essential association in the development of Acanthamoeba keratitis. The bacterial microorganisms that adhere to the surfaces of contact lenses provide a good medium that facilitates attachment, feeding, survival, and growth of Acanthamoeba. Acanthamoeba can easily attach and grow on a lens surface previously loaded with bacterial microorganisms. One study showed that 85% of contact lens systems infected with Acanthamoeba were contaminated with bacterial strains, mainly with the aerobic gram-negative bacilli P. aeruginosa and Xanthomonas maltophila.

Acanthamoeba trophozoites and cysts could retain viable bacteria with human pathogenic potential. Intra-Acanthamoeba detection, survival, growth, and multiplication of salmonellae and P. aeruginosa were reported, with the possibility of reisolating P. aeruginosa from Acanthamoeba cysts. P. aeruginosa could significantly enhance Acanthamoeba trophozoite attachment to hydrogel contact lenses, but not to silicone ones. The combination of P. aeruginosa and Acanthamoeba was assumed to be selectively exclusive, causing potentially devastating ocular infections in contact lens wearers. Sodium salicylate reduced trophozoite attachment to hydrogel lenses when inoculated with P. aeruginosa. This effect was attributed to the inhibition of bacterial biofilmformation, interference with the biofilm-amoebal attachment, or modification of the lens surface.

Contact lens disinfecting solutions:

The use of ineffective contact lens disinfecting solutions is strongly linked to the threat of Acanthamoeba infection in contact lens wearers. A 10-year survey (1994-2004) showed that Acanthamoeba was isolated in contact lenses and contact lens disinfecting solutions in all cases of Acanthamoeba keratitis. The one-step 3% hydrogen peroxide and multipurpose solutions were found to be ineffective in killing Acanthamoeba cysts and trophozoites, as well as bacteria and fungi. However, in addition to the broad antimicrobial activity of multipurpose solutions, they were found to be capable of reducing the adherence capability of Acanthamoeba to contact lenses. Opti-Free express multipurpose solution significantly reduced the adherence of trophozoites and cysts when used to clean, rinse, and soak soft contact lenses. Complete Easy Rub multipurpose solution was effective in removing bacteria, fungi and Acanthamoeba from silicone hydrogel lenses.

Problems Caused by Contact Lens Wearers

Contact Lens Overwear

Corneal overwear-related problems could develop in the long term for any type of contact lenses, including those designed for extended wear. The overwear problems were influenced by the rate of oxygen transmission and permeability through the lens material, lens thickness, lens type, wearing modalities, replacement schedule, repeated wear of disposable lenses, and overnight sleep in lenses. A lower incidence of microbial keratitis was reported for silicone hydrogel lenses with high oxygen permeability than for other soft lenses having low oxygen permeability used with an extended wear scheme. However, occasional pathophysiological problems, such as diffuse corneal infiltration, development of mucin balls, superior epithelial arcuate lesions, contact lens papillary conjunctivitis, corneal erosions, corneal dryness and discomfort, central corneal thinning, and thickened conjunctival epithelium due to increased metaplasia were reported with the overwear of silicone hydrogel lenses with high oxygen permeability. A significantly higher risk of bacterial keratitis and a greater incidence of complications, such as limbal neovascularisation and corneal oedema, were reported in wearers whose daily wear time was higher than 12 hours.

Overnight Sleep in Different Types of Contact Lenses:

The cornea gets its oxygen supply directly from the air when the eye is opened and from the surrounding blood vessels when it is closed. The new versions of rigid and soft contact lenses were designed to allow oxygen delivery to the cornea at an almost similar level under either opened or closed-eye conditions. However, corneal hypoxia, subepithelial infiltrations, immune ring formation, changes in corneal curvature, central corneal thinning, alteration in the number of polymorphonuclear leukocytes, and variations in the level of different inflammatory mediators in the tear film were reported upon wearing contact lenses for multiple sleep cycles. The results of various surveys suggested that the overnight wear of contact lenses was the main cause of microbial keratitis, with a greater concern for the immunocompromised patients, where the risk of unusual infections was very high.

The overnight wear-related corneal changes and the risk of ulcerative keratitis was found to be significantly dependant on the lens type. Overnight wear of rigid gas-permeable contact lenses was associated with higher levels of corneal hypoxia and epithelial oedema, as compared with soft lenses

Non-Compliant Contact Lens Users

The compliance of contact lens wearers with the recommended lens care hygiene procedures is crucial to reduce the risk of serious infections. The use of tap water for the care of contact lenses was widely accepted as the main risk factor in Acanthamoeba infection.

The compliance of contact lens users with the recommended care procedures is ineffective if these solutions do not manage to kill Acanthamoeba. To avoid the persistent use of non-sterile solutions by non-compliant lens wearers, Moore recommended heat disinfection of lenses-between 70 and 80°C for 10 minutes-and the use of 3% hydrogen peroxide for 2-3 hours, 0.001% thimerosal with edetate for 4 hours, 0.005% benzalkonium chloride with edetate for 4 hours, 0.001% chlorhexidine for 4 hours or 0.004% chlorhexidine for 1 hour. Better compliance of contact lens wearers was achieved with the introduction of multipurpose solutions. The multipurpose solutions replaced the need for an additional rinsing solution, offering a single solution for the cleaning, disinfection and contact lens storage. The multipurpose solutions provided potent antimicrobial protection with less toxic and less allergenic effects.

The non-compliance of contact lens users could occur in the case of deliberate reuse of daily disposable contact lenses, when wearing expired lenses without replacement or if using cheap contact lenses purchased from unlicensed vendors.Old contact lenses could colonise more microorganisms due to the increased lens surface tear and wearrelated scratches or to the accumulated deposits. The relationship between repeated use of daily disposable lenses and risk of Acanthamoeba and microbial keratitis is well established.

Daily disposable lenses were designed for single use only, where a new sterile set should be opened every morning and discarded in the evening. This wear modality aimed to provide a great hygienic advantage, by avoiding the necessity and the cost of disinfecting solutions and storage cases. For hygienic purposes, daily disposable lenses were recommended for those lens wearers having jobs entailing a great potential risk of infection, such as hospital staff members.

Conclusion

Contact lens wear is the main cause of ulcerative keratitis, which could get seriously complicated with corneal scarring and lead to permanent vision loss. The association between Acanthamoeba keratitis and contact lens wear is firmly established. Contact lenses have a great impact on corneal epithelium integrity. This, added to the greater affinity of Acanthamoeba to adhere to either corneal or lens surfaces, increase the risk of keratitis in contact lens wearers. Lens hygiene, lens care solutions, wearing modalities and the compliance of lens users are important factors in the lens-keratitis relationship. Every lens wearer should be aware of what the main risk factors are and, when given the routine instructions regarding lens fitting and care, they should also be provided with a thorough explanation of how contact lens misuse can seriously affect vision

References

1. Ibrahim Y.W., Boase D.L., Cree I.A. Factors affecting the epidemiology of Acanthamoeba keratitis. Ophthalmic Epidemiol. 2007;14:53-60. [PubMed]
2. Awwad S.T., Heilman M., Hogan R.N. Severe reactive ischemic posterior segment inflammation in Acanthamoeba keratitis: a new potentially blinding syndrome. Ophthalmology. 2007;114:313-320. [PubMed]
3. Hassanlou M., Bhargava A., Hodge W.G. Bilateral Acanthamoeba keratitis and treatment strategy based on lesion depth. Can J Ophthalmol. 2006;41:71-73. [PubMed]
4. Rama P., Matuska S., Vigano M., Spinelli A., Paganoni G., Brancato R. Bilateral Acanthamoeba keratitis with late recurrence of the infection in a corneal graft: a case report. Eur J Ophthalmol. 2003;13:311-314. [PubMed]
5. Radford C.F., Lehmann O.J., Dart J.K. Acanthamoeba keratitis: multicentre survey in England 1992-6. National Acanthamoeba Keratitis Study Group. Br J Ophthalmol. 1998;82:1387-1392. [PMC free article] [PubMed]
6. Butler T.K., Males J.J., Robinson L.P. Six-year review of Acanthamoeba keratitis in New South Wales, Australia: 1997-2002. Clin Experiment Ophthalmol. 2005;33:41-46. [PubMed]
7. Verhelst D., Koppen C., Van Looveren J., Meheus A., Tassignon M.J., The Belgian Keratitis Study Group Contact lens-related corneal ulcers requiring hospitalization: a 7-year retrospective study in Belgium. Acta Ophthalmol Scand. 2006;84:522-526. [PubMed]