Contact Lens Update
CLINICAL INSIGHTS BASED IN CURRENT RESEARCH

Is contact lens deposition good or bad?

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Lakshman Subbaraman, PhD, BSOptom is Head of Biological Sciences at the Centre for Contact Lens Research, in the School of Optometry and Vision Science at the University of Waterloo.

It is estimated that there are more than 140 million contact lens wearers worldwide. A recent paper reported that the contact lens market is healthy[1] and this market is estimated at approximately $7.6 billion in the world and $2.5 billion in the United States. Despite this buoyant trend, one of the major issues related to contact lens wear is the number of patients that drop out of lens wear every year and the main reason for this drop out has been attributed to contact lens discomfort (CLD).

CLD has attracted a significant amount of interest amongst practitioners, researchers and the industry alike. Over the past decades, numerous studies have been conducted to determine the factors that influence CLD. A recent publication on CLD by the Tear Film and Ocular Surface Society (TFOS) indicates that this condition can be induced by several factors,[2] which can broadly be classified into three groups:

1. Contact lens-related
2. Patient-related
3. Environmental

There are several contact lens material-related factors that are believed to play a role in determining comfort during lens wear.[3] The material-related factors include wettability, coefficient of friction, water content, dehydration and deposition of certain tear-derived components.[3]

The human tears have a complex composition, consisting of a wide variety of proteins, lipids, mucins and electrolytes, which have varying functions. These tear components deposit on the contact lenses within the first few minutes of wear and accumulate over time, depending on the composition of the lens material. Deposition of tear components on contact lenses has been traditionally thought to be detrimental to lens wear as they have been believed to cause CLD and inflammatory or immune responses such as papillary conjunctivitis.[4,5] Despite this common belief, interestingly, to-date, there is no empirical evidence to suggest that deposition on contact lenses will necessarily cause discomfort, as no correlation has been reported between CLD and the absolute levels of total or individual tear proteins and lipid deposition on contact lens materials.[3]

Is protein deposition harmful or beneficial?

Over 1000 proteins have been detected in the human tear film[6] and several of them have antibacterial and anti-inflammatory functions.[7] Among these proteins, lysozyme has been extensively studied and is often used as a marker for deposition studies, since this protein has been found to deposit the most on hydrogel contact lens materials.[7] Lysozyme is an antibacterial and anti-inflammatory protein which is found in high concentration in the tears. It is a relatively small protein (14kDa) with a positive charge and has a great affinity for negatively charged

materials such as the FDA group IV lenses that are ionic and have a high water content.[7] Despite the high rate of lysozyme deposition on conventional hydrogel materials, lysozyme found on group IV lenses such as etafilcon A lenses retains its activity when compared to silicone hydrogel lens materials.[8-11] One study found that there is a strong association between the activity of lysozyme found on etafilcon A contact lens materials and subjective comfort during one day of wear of etafilcon A lens material.[12] Moreover, this study showed that there was no association between total lysozyme and total protein deposited on the etafilcon A lens material and any other clinical signs and symptoms. Other studies have also failed to show a correlation between protein deposition and CLD.[3] This seems to suggest that the conformational state of the deposited protein will have a greater influence in determining subjective comfort than the total quantity of the protein.

Some papers have suggested that contact lens-induced papillary conjunctivitis is an immunological response that might be associated with the denaturation of protein deposited on the lenses and not necessarily due to the total amount of protein.[4, 13] Furthermore, using an in vitro model, a recent study showed that denatured lysozyme can have a detrimental effect on human corneal epithelial cells.[14] This study showed that when the human corneal epithelial cells were exposed to denatured lysozyme in solution, there was a reduction in the metabolic activity of the cells and the cells released pro-inflammatory cytokines. Therefore, it is of significant relevance to study the conformational state of the protein and not merely the absolute level of protein in isolation.

Current literature indicates that lysozyme deposition on contact lenses does not modulate bacterial adhesion to lenses[15, 16] nor do the protein deposits reduce contact lens wettability.[17,18] Although albumin deposits increase binding of bacteria to contact lenses, proteins such as lactoferrin on contact lenses have the ability to reduce the viability of Gram-negative bacteria such as Pseudomonas aeruginosa,[16] which are involved in the pathogenesis of contact lens related microbial keratitis.

In summary, protein deposition on contact lenses has traditionally been believed to reduce comfort during contact lens wear; however, based on the current evidence,[7] it appears that not all protein deposits are bad. The deposition of tear proteins such as lysozyme and lactoferrin on contact lenses may potentially not be harmful, but actually beneficial to contact lens wearers, particularly when they remain in their native state.

What about lipid deposition on contact lenses?

As with protein deposition, lipid deposits on contact lenses have also been believed to have a detrimental effect on the properties of lenses potentially resulting in CLD. Interestingly, there is no report in the literature showing significant correlation between lipid deposition and decreased comfort.[3] Zhao and colleagues[19] determined the correlation between the amount of cholesterol on silicone hydrogel lenses and clinical responses and found a weak negative association between cholesterol deposits on contact lenses and comfort. Jones and co-workers[20] indicated that despite an increased amount of total lipid deposition on conventional hydrogel lenses after three months of wear, comfort responses remained unchanged. Another group of researchers reported similar results.[21] Interestingly, results from a recent study showed that a group of asymptomatic lens wearers had higher amounts of cholesterol, cholesteryl ester and triolein deposited on their contact lenses when compared to the symptomatic group.[22]

Lipids deposited on contact lenses can degrade[23] and this phenomenon may contribute to the end-of-day discomfort of symptomatic lens wearers.[24] Glasson and colleagues[24] showed that malondialdehyde (biomarker of lipid oxidation) levels are higher in the tears of intolerant contact lens wearers compared to a tolerant group of lens wearers. To date, very little information is available on the degraded levels of lipids on contact lenses.[23] The impact of oxidation of lipid deposits on contact lens wear and how these changes in the lipid structure could modulate contact lens-related discomfort remains to be elucidated.

It is interesting to note that two studies have shown that lipid deposition can improve contact lens wettability.[25,26]

Lorentz and coworkers[25] used a sessile drop contact angle technique to analyze the wettability of conventional and silicone hydrogel lens materials when soaked in an artificial tear solution containing lipids such as triolein, cholesterol, oleic acid, oleic acid methyl ester and cholesteryl oleate, and showed that exposure to lipids may improve the wettability of certain lens types. One of the functions of the lipids in tears in to provide lubrication. It would be interesting to see if the deposition of these specific lipids that improve lubrication would reduce the friction between eyelid and the front surface of the lenses.

Cholesterol has been suggested to have an antimicrobial effect against some species of bacteria. Marquart and colleagues[27] infected rabbits' cornea with S. pneumoniae and used topical drops of 1% cholesterol to treat them. They found that 1% cholesterol is an effective treatment for S. pneumoniae keratitis. Further work is needed to determine if cholesterol deposition/coating on contact lenses will demonstrate any level of efficacy against other bacteria relevant to the ocular surface.

Conclusions

In conclusion, contrary to the popular belief that all deposits on contact lenses are bad, a careful review of the literature coupled with recently available data indicates that "selective" deposition of certain tear-derived components could be beneficial to lens wear, and not detrimental. It is important that protein deposits on contact lenses retain their native conformational state and that lipid bound to the lenses does not undergo degradation. Further work is needed to determine the absolute amount of deposits that should remain on contact lenses that would result in providing the maximum benefit to the wearer. It would be valuable to develop contact lenses and lens care products that can retain the native state of the deposited proteins/lipids and evaluate their impact on comfort. Further, it would appear that it may be worthwhile to develop contact lens materials that can selectively bind "good" proteins/lipids and lens care products that can selectively remove "bad" deposits and also retain the activity of protein and resist the degradation of lipids.

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