Hydrophobic Domains in Silicone Hydrogel Contact Lenses

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Introduction: Of the 35 million contact lens wearers in North America, approximately half experience symptoms of dryness and discomfort during wear.[1] These symptoms most often occur several hours into the lens usage. Discomfort can be due to a variety of factors. A main component of contact lens discomfort is from specific surface changes in the lens (protein and lipid deposition, called biofouling) over the period of lens usage, particularly after overnight/extended wear. Extended wear of contact lenses has been associated with comfort complications that affect roughly 4% of the contact lens wearers every year.[1] Common symptoms of a "biofouled" contact lens include decreased visual acuity, photophobia, degradation of image quality, tearing, redness, and itching.

Silicone hydrogel materials which allow high oxygen and ion permeability have permitted contact lens wear periods to be extended from overnight to 14 and 30 days. The silicone component of these lens materials is inherently hydrophobic and lipophilic and while important for oxygen transmission, increases the biofouling and decrease the tear compatibility of the lens. Manufacturers employ hydrophilic, non-lipophilic surface coatings and surface modifying end groups to mask the hydrophobic nature of the bulk lens polymer.

In our studies we have investigated the degree to which hydrophobic domains on the surface and in the bulk of the lens can be imaged over periods of simulated wear.

Materials and Methods: Sudan IV is a lysochrome diazo dye which we used to image the hydrophobic areas on the surface and in the bulk of silicone hydrogel contact lenses.[2,3] Four types of silicone hydrogel lenses were used in our studies: Acuvue Oasys (Senofilcon A), Acuvue Advance (Galyfilcon A), PureVision (Balafilcon A) and O_2 Optix (Lotrafilcon B). The Artificial Tear Fluid (ATF) used contained 6 major proteins (lysozyme, IgG light chain, α-acid glycoprotein albumin, IgG heavy chain, lactoferrin, and gamma globulin), 5 lipids (cholesterol, cholesterol stearate, sphingomyelin, galactocerebrosides, phosphatylcholine), mucin, salts and buffers. Contact Lenses were pre-soaked for 24 hours in saline (Unisol) to remove any packing solution constituents prior to use. Lenses were tested for hydrophobic domain binding using a saturated solution of Sudan IV in silicone oil. Staining was determined by photography and extraction of the dye by DMSO and analysis at 522nm. Lenses were exposed to ATF using an in-vitro blinking apparatus for 2 and 16 hours and then tested for hydrophobic domain staining.

Results/Discussion: Specific lens differences in hydrophobic staining were found. ATF exposure significantly decreased the hydrophobic staining response for all four lens types (Fig 1).

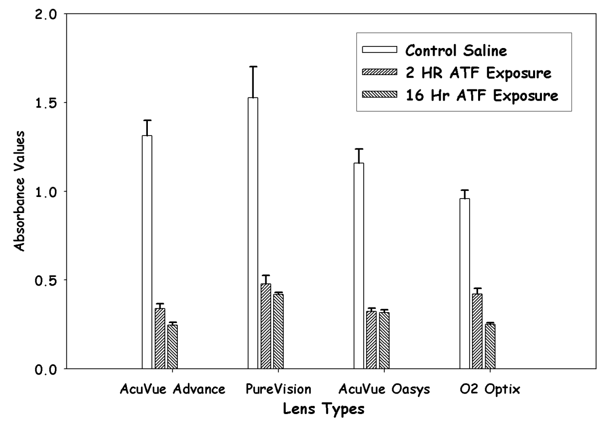

Figure 1: Hydrophobic binding response to contact lenses after ATF exposure.

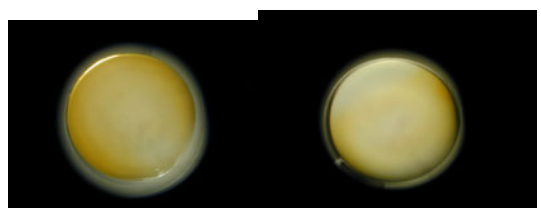

Figure 2: Comparison of picture data between (a) control lens (saline) and (b) ATF soak lens for 2-hour soak interval using Acuvue Advance contact lenses.

The pattern on hydrophobic staining was also specific for each lens type.

Conclusions: Hydrophobic staining of the silicone hydrogel lenses visualized domains on and within the lenses. Differences in staining response after exposure to ATF indicate the potential for increased protein and lipid deposition on the different lens types. Hydrophobic staining techniques may be useful for determining differences in surface modification techniques and biofouling of silicone hydrogel lenses.

References:

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