Surface wettability and deposition

Dr Mohinder Merchea describes the deposition properties of a new lens material and how it influences wettability

Maintenance of a good tear film on the surface of a contact lens is important for optimising quality of vision and contact lens wearing comfort. The wetting of contact lenses is important in maintaining the healthy tear film.[1] Wetting can be described in general terms as the displacement from a surface of one fluid by another, or the spreading of liquids over a solid surface.[2,3] Contact angle measurements have been used to indirectly characterise the wettability of a surface.[1,3,4] The contact angle of a substance is defined as the angle formed between a surface and the tangent to a drop of liquid at the point of interface. The contact angle represents an indirect measure of the surface tension on the surface of a lens material.

Classically, there are three techniques that have been used most frequently to quantify contact angles: sessile drop (a liquid bubble is placed on a solid surface), captive bubble (a gas bubble is placed on the solid surface while immersed in a liquid), and Wilhelmy plate (a solid is immersed and withdrawn from a liquid).[1,5-7] Other techniques, such as the DeNouy Ring method, directly measure surface tension[8] but are more often used to measure the impact of lens care solutions on wettability of a lens surface. Probably the most common method is the use of a sessile drop of liquid deposited onto the surface of the material by a syringe.

Surface wettability of contact lenses is typically assessed *in vitro* by determining water contact angles at the lens interface.[9] A lower contact angle indicates better wettability.[10-12] A representative contact angle is shown in Figure 1.

A novel bio-inspired lens material, nesofilcon A (Biotrue Oneday), was designed to contain 78 per cent water, the same water content as the cornea, while delivering virtually the same oxygen level as the open eye. In addition, the outer surface of the lens is designed to mimic the lipid layer of tear film, which prevents dehydration of the lens, maintains consistent optics and delivers the oxygen level the open eye needs to maintain healthy, white eyes. The dehydration resistance properties of the lens surface allow it to maintain the maximum moisture on the surface of the eye compared to other leading daily disposable lenses.[13-15]

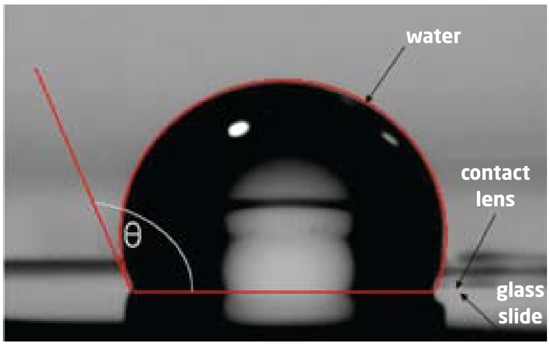

Figure 1 Sessile drop contact angle measurement

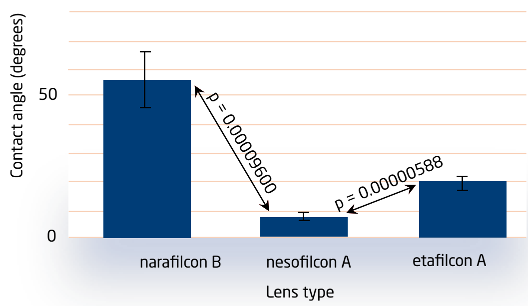

Figure 2 Contact angles of the three lens types tested directly out of the packaging solution with no rinsing

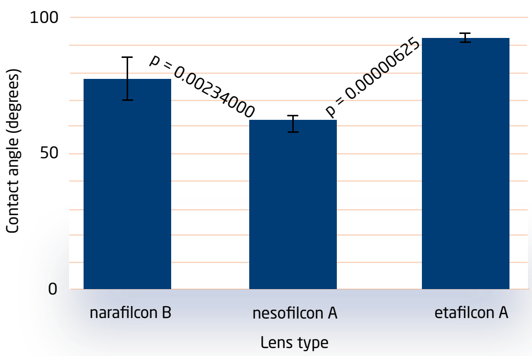

Figure 3 Contact angles of the three lens types tested after soaking for 18 hours in artificial tear fluid containing lysozyme, oleic acid, oleic acid methyl ester, and cholesterol

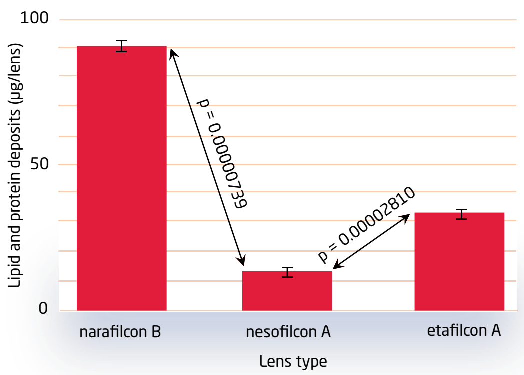

Figure 4 Protein and lipid deposits on the three lens types tested after soaking in artificial tear fluid

Sessile drop contact angle and chromatographic techniques were used to assess the surface wettability and deposition characteristics of this new material compared to two commercially available daily disposable contact lenses. The lenses were analysed both directly out of the packaging solution with no rinsing, and after soaking for 18 hours in artificial tear fluid containing lysozyme, oleic acid, oleic acid methyl ester, and cholesterol.[16] Sessile drop water contact angles were performed by dispensing a 0.6µL droplet of high performance liquid chromatography water onto the anterior lens surface. The sessile drop contact angle was then measured at two different points on the lens. This was repeated using two or three lenses for each lens type and condition.

In addition to measuring surface wettability, the amount of deposits on daily disposable lenses were compared among the three lens types after overnight incubation at 37°C in artificial tear fluid containing lipids and protein in BBS, representing conditions at the end of the day. Lipid deposits were quantified using a gas chromatography method and protein deposits were quantified using a high performance liquid chromatography method.

The novel nesofilcon A daily disposable lens material had a lower sessile drop water contact angle (8°) than both narafilcon B (56°; $p = 9.60 \times 10^{-5}$) and etafilcon A (19°; $p = 5.88 \times 10^{-6}$) lenses when measured directly out of the packaging solution (Figure 2). Likewise, after soaking in artificial tear fluid for 18 hours to model end of day wettability, the nesofilcon A material had a lower contact angle (62°) than both narafilcon B (78°; $p = 2.34 \times 10^{-3}$) and etafilcon A (93°; $p = 6.25 \times 10^{-6}$) (Figure 3).

The nesofilcon A material also demonstrated the lowest overall deposition level after overnight exposure to an artificial tear fluid. Gas chromatography and high performance liquid chromatography demonstrated 13µg/lens combined lipids and proteins were deposited on the test lens material, which is significantly lower than the 90µg/lens ($p = 7.39 \times 10^{-6}$) deposited on narafilcon B and 33µg/lens ($p = 2.81 \times 10^{-5}$) deposited on etafilcon A (Figure 4).

Conclusions

Based on sessile drop contact angle analyses, the *in-vitro* surface wettability of the novel nesofilcon A material was significantly better than either narafilcon B or etafilcon A. The nesofilcon A material also had significantly fewer combined lipid and protein deposits after being soaked in an artificial tear fluid for 18 hours than either the narafilcon B or etafilcon A. Lower total deposition on lenses may enhance wettability for contact lens materials resulting in optimised visual quality and comfort.[17,18]

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Dr Mohinder Merchea, is director of medical affairs, North America, B+L