Wettability of different silicone hydrogel lens materials and blister solutions measured using non-invasive keratographic drying up time (NIK-DUT)

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Introduction:

The wettability of the contact lens surface, along with oxygen transmissibility, are very important material properties that have a crucial impact on the physiological tolerance of contact lenses. In general the wettability is defined as the tendency of liquid to spread over the surface when exposed to a solid object.[1, 2]

If wettability of the contact lens surface is not consistent, visual disturbance, increased affinity for deposits[3] and reduced comfort are the consequences.[4] Since the market share of silicone hydrogel lenses has increased enormously in the last years,[5] scientific research concentrates more and more on these materials and the investigation of their wettability properties.

The standard method to investigate the wettability of contact lens surfaces is the analysis of the contact angle,[6, 7, 8, 9] especially the most prevalent procedures "Sessile Drop" [7, 10] and "Captive Bubble".[11, 6]

To overcome issues like a small area of investigation, contact to the test material or strong investigator related outcomes other methods like "*Placido* ring reflection[12]" may have advantages over previously established analysis methods and are able to capture data to provide information about the dynamics of the wettability process or drying up of lens surfaces.

Purpose:

The primary objective of the study was to determine differences between the surface wettability of silicone hydrogel (SiHy) lens materials and blister pack solutions over time measured in vitro using an experimental modified corneal topographer.

Methods:

The approach of the *in vitro* contact lens wettability analysis was used to determine the drying-up of the lens over time by means of a modified corneal topographer (*K5M, Oculus*) [13]. One of the key measurement values collected is called Non-Invasive Keratograph Drying-Up Time (NIK-DUT).[12]

The NIK-DUT measurement is based on the projection of an illuminated ring pattern onto the contact lens surface and its reflection from it. If the wettability of the contact lens surface is stable and homogeneous at the beginning of the measurement the reflection of the rings is uniform. During the time of measurement the projected ring pattern is examined for signs of surface drying, in particular for distortions and gaps of the ring pattern. The data regarding the change of the reflected ring pattern was captured automatically and independent of the investigator by using a software developed to evaluate alterations of the ring edges objectively (Figures 1-3) and allows a correction by a trained grader if needed.

A pilot study showed that this newly developed method is suitable for a quantification of the contact lens surface wettability under laboratory conditions.[12]

Figure 1: Horizontally mounted Keratograph

Figure 2: Ring reflection from wet lens surface

Figure 3: Detection interface

20 lenses each of the following commercially available SiHy materials and blister solutions were tested: senofilcon A, senofilcon C, comfilcon A, samfilcon A, lotrafilcon B/copolymer 845 and lotrafilcon B copolymer 845+EOBO-41. The NIK-DUT video was captured over 180 sec by a trained investigator and the software evaluated the reflected placido-ring image over time.

To understand the dynamics of dewetting over time, we collected from the NIK-DUT videos, the dry-up area under the curve (AUC, cumulative dry-up % area over 180 seconds) and the time point when 25% of the entire measurement segments showed dry-up during the measuring time (NIK-DUT_S25). Based on asymptotic, not normally distributed data, the Kruskal Wallis test was conducted to determine effect of lens material/blister solution (alpha 0.05)

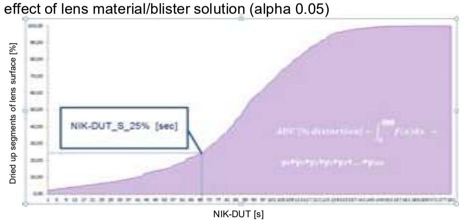

Figure 4:Demo NIK-DUT curve with AUC and 25% value visualisation

Results:

The AUC results were as follows: 9463% comfilcon A, 7964% samfilcon A, 7033% senofilcon A, 6134% senofilcon C, 5592% lotrafilcon B/copolymer 845 and 4680% for lotrafilcon B/ copolymer 845+EOBO-41 and were statistically significantly different, p = 0.001. NIK-DUT_S_25% comparison showed the following order: 72sec comfilcon A, 79sec samfilcon A, 93sec lotrafilcon B/copolymer 845, 96sec senofilcon A, 105s senofilcon C and 123sec for lotrafilcon B copolymer 845+EOBO-41 and were statistically significantly different, p < 0.001. Post-hoc comparisons are shown in Table 1.

In addition to the analytic statistics, a visual analysis of the NIK-DUT was conducted. For that purpose wettability maps and a graphic representation of the drying-up characteristics were created. The segments in the map show the place of the wettability change and the color indicates the time of this change.

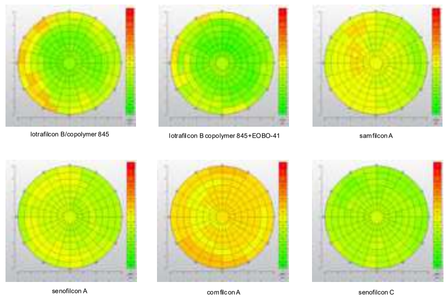

Figure 5: Wettability Maps of the tested lens / blister solution

Table 1: Post Hoc Analysis of AUC data and NIK-DUT_S_25% data sets

Area under curve (AUC): **NIK-DUT_S_25%**	**samfilcon A**	**senofilcon A**	**senofilcon C**	**comfilcon A**	**lotrafilcon B copolymer 845**	**lotrafilcon B copolymer 845 +EOBO-41**
samfilcon A		0.174 0.096	0.034 0.009	0.270 0.030	0.081 0.012	0.002 <0.001
senofilcon A			0.922 0.117	0.067 <0.001	0.312 0.074	0.903 <0.001
senofilcon C				0,012 <0.001	0,046 0.213	0,578 0.009
comfilcon A					0.002 0.002	<0.000 <0.001
lotrafilcon B copolymer 845						0,001 0.704
lotrafilcon B copolymer 845 +EOBO-41						

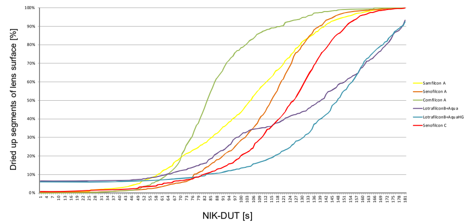

Figure 6: NIK-DUT curves of different lens material measured out of blisters

Conclusion:

The study showed statistically significant differences in the wettability performances among different lens materials measured directly out of the packaging solution.

Within lotrafilcon B lenses, the interaction of EOBO-41 added to the blister solution with the lens maintained the wettability of the lens surface longer.

Blister solutions containing specifically designed agents to improve lens surface wettability may bring benefits like improved comfort, and vision to the contact lens wearer.

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