Assessment of the wettability of different silicone hydrogel contact lenses using a novel *in vitro* method

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Introduction:

The wettability of the contact lens surface, along with oxygen transmissibility, is a very important material property that has a crucial impact on the physiological tolerance of a contact lens. 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 no consistent wettability of the contact lens surface is present, visual impairment, increased affinity for deposits[3] and reduced comfort are the consequences.[4] Since the market share of Silicone Hydrogels 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]

Purpose:

The aim of the study was to determine differences between the surface wettability of various lens/solution combinations in terms of the drying-up time measured *in vitro* using a modified corneal topographer (Non-Invasive *Keratograph* – Drying-Up Time (NIK-DUT)).

Methods:

A new approach of the *in vitro* contact lens wettability analysis was used to determine the drying-up time by means of a modified corneal topographer (*Keratograph, Oculus*). The measurement value 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.

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

The advantages over previously established analysis methods are the large measuring range by which almost the entire area of the contact lens can be examined, the contactless investigation and the automatic software-assisted evaluation with minimal subjective influence.

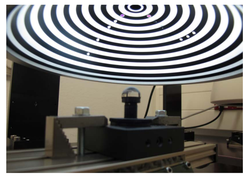

Figure 1: Horizontally mounted Keratograph

Figure 2: Ring reflection from wet lens surface

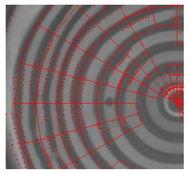

Figure 3: Objective detection

Five market-leading silicone hydrogel SCLs underwent a washing procedure and were soaked subsequently in OPTI-FREE® PureMoist® MPDS (OFPM) whereas Sensitive Eyes® Plus Saline (saline) served as reference (10 combinations in total). The NIK-DUT was measured ten times for every combination by evaluating the reflected placido-ring image objectively. The focus was on the measurement of the NIK-DUT value derived when 25% of the entire measurement segments showed dry-up during the measuring time (NIK-DUT_S25). Based on an asymptotic, normally distributed mean value, an analysis of variance (ANOVA, alpha=0.05) and subsequently a post-hoc analysis (Duncan) was conducted to determine inter-group comparisons.

Results:

Within and between the 10 combinations the differences were statistically significant ($p<0.001$). The following NIK-DUT_S25 values were achieved in combination with saline and OFPM respectively: Lotrafilcon B with Aqua Technology (129.0±15.1s and 154.1±5.5s); Lotrafilcon A (120.8±20.5s and 140.9±12.8s); Comfilcon A (123.5±7.9s and 149.5±7.6s); Balafilcon A (128.3±16.3s and 131.4±8.0s); Senofilcon A (123.2±5.1s and 191.6±23.4s).

Table 1: NIK-DUT S25 data [s]

Lens / lens solution combination		AVE	SD	SD [%]	95%-CI lower bound	95%-CI upper bound	Min.	Max.
Balafilcon A	Saline	128.29	16.29	12.7	115.77	140.81	98.47	158.00
	OFPM	131.36	8.02	6.1	125.63	137.10	121.40	144.63
Lotrafilcon B	Saline	128.95	15.10	11.7	118.15	139.75	98.60	146.85
	OFPM	154.06	5.49	3.6	150.13	157.99	144.88	159.58
Lotrafilcon A	Saline	120.76	20.54	17.0	106.07	135.46	84.89	150.16
	OFPM	140.88	12.80	9.1	131.73	150.04	126.04	164.98
Comfilcon A	Saline	123.46	7.93	6.4	117.79	129.14	109.33	133.94
	OFPM	149.47	7.64	5.1	144.01	154.94	139.06	160.85
Senofilcon A	Saline	123.20	5.09	4.1	119.56	126.84	116.33	134.44
	OFPM	191.59	23.38	12.2	174.87	208.32	141.53	224.01

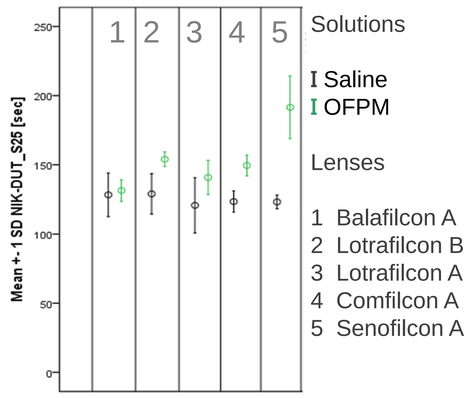

Figure. 4: Comparison of the tested combinations when 25% of the segments did show drying up effects

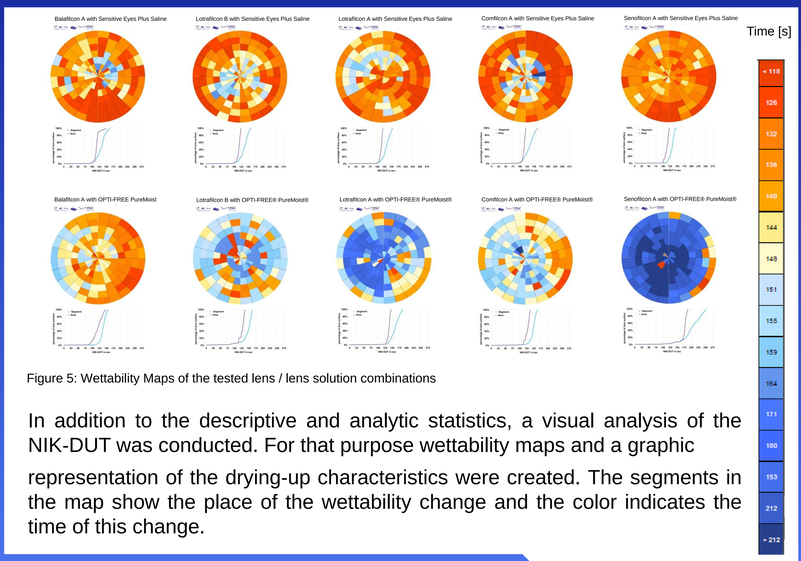

Figure 5: Wettability Maps of the tested lens / lens solution combinations

In addition to the descriptive and 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.

Conclusion:

There are significant differences in wettability between the tested SCL materials and test solutions. The wettability values were higher for all lenses when they were pre-soaked in Opti-Free PureMoist. Increasing lens wettability through use of a lens care solution with a wetting agent designed to interact with silicone material may have a positive impact on the patient’s lens wearing experience.

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