Effects of temperature and blinking on contact lens dehydration of contemporary soft lens materials using an *in vitro* blink model

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Introduction

- When contact lenses (CLs) are worn, they are exposed to the environment and begin to dehydrate due to evaporation[1] and changes in temperature.[1,2]
- Len hydration has an effect on CL diameter,[4] fit,[5] and oxygen transmissibility,[6] which could affect lens comfort.[3]
- This study evaluated the effects of temperature and blinking on the dehydration of CLs using an advanced *in vitro* blink model.

Purpose

- To evaluate the effects of temperature and blinking on CL dehydration using an *in vitro* blink model.

Methods

- Three silicone hydrogel (delefilcon A, comfilcon A, senofilcon A) and two conventional hydrogel (etafilcon A, omafilcon A) lens materials were evaluated at 0, 1, and 16 hours. Modalities were either daily disposables (DD) and/or reusable (RU) lenses.

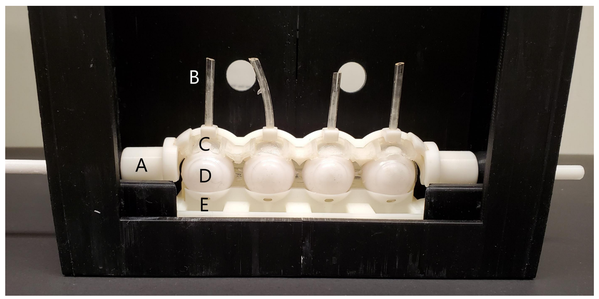

Figure 1 *In vitro* eye blink model used in this study. (A) Connector from eyelid to blink motor. (B) Tubing for artificial tear fluid. (C) Eyelid. (D) Silicone eyeball. (E) Lower eyelid with trough to hold excess tear fluid.

- The water content (WC) of the CLs was measured using a gravimetric method.[5]
- Lenses were incubated on a blink model, internally heated using liquid heating to achieve a surface temperature of 35°C. (Figure 1)
- An artificial tear solution (ATS) was delivered to the eye model at a rate of 4.5 µL/min and with a blink rate of 6 blinks/min.
- Control lenses were incubated in vials containing either 2 mL of ATS or phosphate-buffered saline (PBS) at 35°C and 22°C.

Results

- Lower WC was observed for all lens materials after 1 hour at ocular temperature (35°C) compared to room temperature (22°C) in the vial ($p < 0.005$) (Figure 2A, Table 1).
- For most lens types, there were no significant differences between incubation in ATS or PBS in the vial ($p > 0.05$, Table 1).
- With the vial system, the WC decreased and plateaued over time (Figure 2A, Table 1).
- On the blink model, the WC decreased after 1 hour, but reverted higher towards the initial WC levels (Figure 2B).

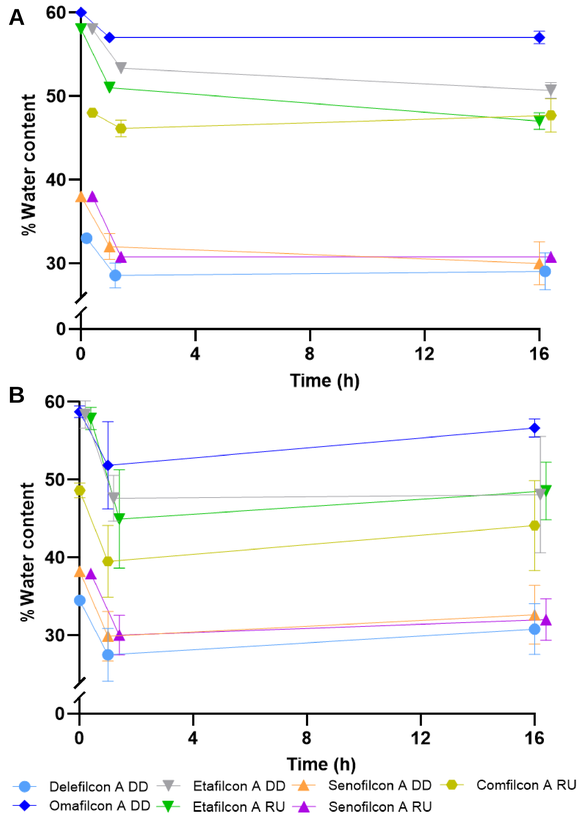

Figure 2. Percent water content of contact lenses over time in the (A) vial and (B) blink models with artificial tear solution at ocular temperature (35°C). DD, daily disposables; RU, reusable.

Table 1. Equilibrium water content of various lens materials measured after vial incubation in two test solutions and at two temperatures

Contact lens material NWC (n=5 each)	PBS				ATS			
	EWC (%) at RT (Mean ± SD)		EWC (%) at OT (Mean ± SD)		EWC (%) at RT (Mean ± SD)		EWC (%) at OT (Mean ± SD)	
	1hr	16hr	1hr	16hr	1hr	16hr	1hr	16hr
Delefilcon A 33% DD	34.48 ± 0.00	34.48 ± 0.00	29.09 ± 1.21	29.09 ± 1.21	29.55 ± 2.61	34.01 ± 1.05	28.55 ± 1.48	29.05 ± 2.20
Senofilcon A 38% DD	36.32 ± 1.93	35.17 ± 1.09	32.63 ± 2.31	32.26 ± 0.00	35.94 ± 1.62	34.38 ± 0.00	32.23 ± 1.55	30.84 ± 2.57
Etafilcon A 58% DD	53.01 ± 0.72	52.69 ± 0.88	50.00 ± 0.00	46.95 ± 1.09	54.54 ± 0.67	55.12 ± 0.63	53.33 ± 0.00	50.69 ± 0.94
Omafilcon A 60% DD	59.62 ± 0.55	59.38 ± 0.00	58.33 ± 0.59	58.06 ± 0.00	58.06 ± 0.00	58.59 ± 0.72	57.78 ± 0.63	57.23 ± 0.77
Comfilcon A 48% RU	48.06 ± 2.45	48.89 ± 1.01	47.32 ± 1.86	46.52 ± 1.73	49.23 ± 1.72	49.63 ± 0.83	46.12 ± 1.47	47.69 ± 2.11
Senofilcon A 38% RU	35.71 ± 0.00	35.71 ± 0.00	30.77 ± 0.00	30.77 ± 0.00	35.71 ± 0.00	34.76 ± 1.30	30.77 ± 0.00	30.77 ± 0.00
Etafilcon A 58% RU	55.61 ± 0.60	55.06 ± 1.16	52.52 ± 0.83	52.82 ± 0.68	53.69 ± 0.78	54.81 ± 0.60	51.61 ± 0.00	47.54 ± 1.01

NWC, nominal water content; PBS, phosphate buffered saline; ATS, artificial tear solution; EWC, equilibrium water content; DD, daily disposables; RU, reusable. RT, room temperature, 22°C; OT, ocular temperature 35°C.

Conclusions

- The reduction in WC of CLs on the eye may be due to both an increase in temperature and dehydration from air exposure and blinking.
- This study showed that the developed heated blink model can be used to provide insights to CL dehydration on the eye.

References and Funding

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