



The effect of oxygen transmissibility on central and peripheral overnight corneal swelling with four different silicone hydrogel lenses

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Introduction

- Holden and Mertz hypothesized that a minimum oxygen transmissibility (Dk/t) of a lens should be 87 ± 3.3 (barrers/cm) in order to prevent overnight corneal swelling.¹ More recently, a value of 125 (barrers/cm) has been proposed as the critical Dk/t of a lens to prevent lens-induced overnight corneal anoxia.²
- Studies have shown that silicone hydrogel lenses induce less corneal swelling compared to conventional hydrogel lenses when worn overnight.³⁻⁷
- This is the first study comparing overnight corneal swelling induced by four different Silicone hydrogel lenses with three different powers.

Purpose

To compare central and peripheral corneal swelling after 8 hours of sleep in eyes wearing silicone hydrogel lenses with various oxygen transmissibilities (Dk/t).

Materials & Methods

Study Design

- Twenty nine neophyte subjects wore lotrafilcon A, balafilcon A, galyfilcon A and senofilcon A lenses using powers -3.0, -10.0 and +6.0 D in each material on separate nights, in random order, and in one eye only.
- The contra-lateral eye (no lens) served as the control.
- All the subjects were non contact lens wearer.
- Corneal thickness was measured at the centre, 2.3 and 3.4mm from the centre using a digital optical pachometer before lens insertion, immediately after lens removal on waking, then 20, 40 minutes, 1, 2 and 3 hours later.

Table 1: Lens Parameters

Lens	Material	Manufacturer	Dk (Barrers)	Central Dk/t (Barrers / cm) (Nominal for -3.00)	Power
Night & Day™	Iotrafilcon A	Ciba Vision	140	175	-3.00
					-10.00
					+6.00
PureVision™	Balafilcon A	B&L	91	101	-3.00
					-10.00
					+6.00
Acuvue Advance™	galyfilcon A	J&J	60	86	-10.00
					-3.00
					+6.00
Acuvue OASYS™	senofilcon A	J&J	103	147	-3.00
					-10.00
					+6.00

Results

Averaged for power, there was a significant difference in central swelling across lenses, lotrafilcon inducing the least (6.2 ± 2.8 %) and galyfilcon the most (7.6 ± 3.0 %) at the centre (ANOVA, $p < 0.001$). There was no difference between galyfilcon balafilcon and senofilcon, and between lotrafilcon and senofilcon (post-hoc tests; $p > 0.05$) (Figure 1).

Immediately after lens removal, all lenses induced significantly more central corneal swelling than their respective controls (all post-hoc tests; $p < 0.05$) (Figure 1).

There was a significant effect of corneal position on overnight swelling when averaged over lens and power (ANOVA; $p < 0.001$) (Figure 2). There was no difference between central and 2.3 mm inferior corneal position (7.0 ± 2.8 % vs. 6.6 ± 2.8 %, post-hoc test; $p > 0.05$). Corneal swelling at both these positions were significantly greater than the 3.4 mm position (5.9 ± 2.8 %) (post-hoc tests; $p < 0.05$ for both).

As shown in Figure 3, corneal swelling in both para-central 2.3 mm and mid-peripheral 3.4 corneal positions followed the same trend as central swelling; lotrafilcon inducing the least and galyfilcon inducing the most amount of corneal swelling across the study lenses. The difference was only significant at the central and 2.3 mm locations (ANOVA; $p < 0.001$).

Following lens removal lotrafilcon induced significantly less central corneal swelling than balafilcon and galyfilcon (all post-hoc tests; $p < 0.05$) for the first hour but up to 40 minutes for senofilcon (all post-hoc tests; $p > 0.05$) (Figure 4).

Figure 1: Overnight central corneal swelling (lens vs. control)

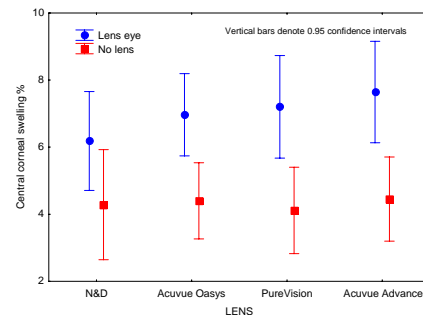


Figure 2 : Effect of position on corneal swelling

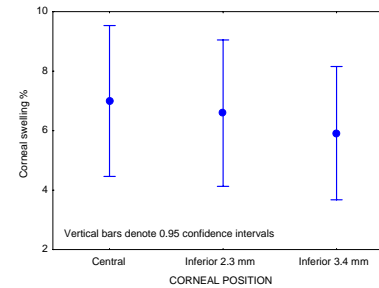


Figure 3: Overnight corneal swelling by corneal position for each lens

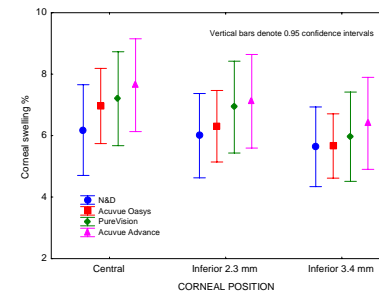
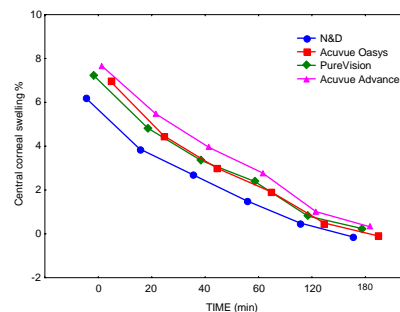


Figure 4: Central corneal de-swelling in test eyes



Conclusions

- The differences in central and paracentral corneal swelling of the test eyes are consistent with the differences in oxygen transmission of the silicone hydrogel lenses in this study.
- Greater corneal swelling in the centre than the mid-peripheral cornea in this study was not dependent on the lens material, and is supported by previous findings using conventional hydrogel⁸⁻⁹ or PMMA¹⁰ lenses.
- Overnight wear of each lens in this study induced more corneal swelling than the non-wearing contralateral control eyes as shown previously.^{4,7,11}

References

- Critical Oxygen Levels to Avoid Corneal Edema for Daily and Extended Wear Contact-Lenses. Holden B, Mertz G. Investigative Ophthalmology & Visual Science 1984;25:1161-1167.
- Re-evaluation of the oxygen diffusion model for predicting minimum contact lens Dk/t values needed to avoid corneal anoxia. Harvitt DM and Bonanno JA. Optom Vis Sci 1999;76:712-719.
- Overnight clinical performance of a high Dk silicone hydrogel soft contact lens. Comstock T, Robby M, Cox I. Contact Lens Anterior Eye 1999;22:159.
- Sympathetic swelling response of the control eye to soft lenses in the other eye. Fonn D, du Toit R, Simpson TL, Vega JA, Situ P, Chalmers RL. Invest Ophthalmol Vis Sci 1999, 40:3116-3121.
- Uniformity of overnight corneal swelling with extended wear contact lenses. Bergenske P, Mueller N, Caroline P, et al. Optom Vis Sci 2001;78 (125):198.
- Overnight corneal swelling with 7-day continuous wear of soft contact lenses. Bullimore MA, Nguyen M, Bozic J, et al. Invest Ophthalmol Vis Sci 2002, 43: ARVO E-Abstract 3100.
- Confirmation of a yoked corneal swelling response between the test and contralateral control eye. Fonn D, Moezzi A, Simpson T, et al. Optom Vis Sci 2004;81(125):30.
- Topographical corneal edema. Holden B, McNally J, Mertz G, Swarbrick H. Acta Ophthalmol (Copenh) 1985; 63:684-91.
- Contact lens induced corneal swelling and surface changes measured with the Orbscan™III Corneal Topographer. Moezzi A, Fonn D, Simpson T, Sorbara L. Optom Vis Sci 2004 Mar; 81(3):189-93.
- Comparative physiologic performance of polymethyl methacrylate and gas permeable lenses. Fonn D, Holden B, Roth P, Gooley G, Kenefick J. Arch Ophthalmol 1984;102:760-764.
- Overnight Corneal Swelling of Silicone Hydrogel Contact Lenses with High Oxygen Transmissibility. Moezzi A, Fonn D, Simpson T. Eye & Contact Lens 2006 Dec 32(6):277-80.

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