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.2,3
- This is the first study comparing overnight corneal swelling induced by four different Silicone hydrogel lenses with three different powers.

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 wearers.
- Corneal thickness was measured at the centre, 2.3 and 3.4 mm from the centre using a digital optical pachometer before lenses insertion, immediately after lens removal on waking, then 20, 40 minutes, 1, 2 and 3 hours later.

Table 1: Lens Parameters

<table>
<thead>
<tr>
<th>Lens</th>
<th>Manufacturer</th>
<th>Material</th>
<th>3.4 mm Central Dk/t (Barrers/cm)</th>
<th>Power</th>
<th>3.4 mm Central Dk/t Nominal for -3.00</th>
<th>3.4 mm Edge Dk/t Nominal for -3.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Night &amp; Day™</td>
<td>Ciba Vision</td>
<td>lotrafilcon A</td>
<td>140</td>
<td>-10.00</td>
<td>-10.00</td>
<td>-10.00</td>
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<tr>
<td>PureVision™</td>
<td>Bausch &amp; Lomb</td>
<td>balafilcon A</td>
<td>91</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Acuvue Advance™</td>
<td>J&amp;J</td>
<td>galyfilcon A</td>
<td>60</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Acuvue OASYS™</td>
<td>J&amp;J</td>
<td>senofilcon A</td>
<td>103</td>
<td>147</td>
<td>147</td>
<td>147</td>
</tr>
</tbody>
</table>

Table 1: Lens Parameters

Average 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 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).

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 hydrogel5 or PMMA6 lenses.
- Overnight wear of each lens in this study induced more corneal swelling than the non-wearing contralateral control eyes as shown previously.7,11

Acknowledgements

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References