The Influence of Soft Contact Lens Materials on the Central, Para-Central and Peripheral Corneal Endothelium

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The influence of soft contact lens materials on the central, para-central and peripheral corneal endothelium

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ABSTRACT

PURPOSE: To examine the influence of a variety of soft contact lens (SCL) materials on the corneal endothelium, prior to and following two weeks of continuous wear of SCL.

METHODS: Corneal endothelial cells were examined using a CEM-530 specular microscope (Nidek; Japan). Full-time SCL wearers (n = 31 eyes) were compared to a non-contact lens (NCL) control group (n = 28 eyes) of a similar age (SCL: 20.82 ± 1.69 years, NCL: 21.4 ± 2.85 years, p = 0.58). Parameters assessed were endothelial cell density (ECD; cells/mm²), mean cell area (MCA, µm²), coefficient of variation (CV) and hexagonality (%).

RESULTS: Prior to SCL wear, two-way ANOVA testing showed significant differences between silicone hydrogel (SH) SCL materials for the CV at 10°, with generation 2 SiH (G2SiH) wearers showing increased CV (27.67 ± 3.78) compared to generation 4 SH (G4SH) wearers (24.50 ± 3.73, p < 0.01). CV at the superior periphery was significantly lower in the NCL group (25.63 ± 2.79) compared to the hydrogel group (29.62 ± 6.22, p = 0.001). The MCA in the inferior periphery was also significantly higher in the NCL group (346.92 ± 36.75) compared to the hydrogel group (314.92 ± 16.57, p = 0.03).

Following 14 days SCL wear, no statistically significant differences in stability of endothelial parameters were detected between NCL and SCL material groups (all p-values > 0.05).

CONCLUSION: SCL wear has an effect on para-central and peripheral corneal endothelial measurements in SCL wearers compared to NCL wearers; with largest significant differences seen between NCL and hydrogel SCL wearers. Following two weeks SCL wear, there were no significant differences in the stability of all endothelial measurements, regardless of which SCL material was worn.

BACKGROUND

Corneal hypoxia due to over-wear of low oxygen transmissibility (Dk/T) SCLs results in endothelial polymorphism and corneal thinning. High Dk/T SH materials are reported to have negligible effects on the corneal endothelium 1.

Hypothetical: endothelial parameters would show greater variation in a full-time low Dk/T hydrogel SCL wearing group compared to a high Dk/T SH wearing group or NCL control group.

Reframing previous low Dk/T CL wearers with higher Dk/T CL lens results in reversal of hypoxia-induced endothelial changes 2. It is proposed that this reversal is linked to both the resolution of hypoxia and due to a mechanical reorganisation of the corneal endothelium following resolution of cell loss-induced increased corneal thickness (4). The stability of endothelial parameters in this study was examined over a two week period following cessation of SCL wear. This time period was chosen as it is the recommended SCL wear cessation time prior to corneal thinning 5. Although the parameters of endothelial function have been previously demonstrated to be stable, this study aimed to confirm if such parameters were stable following cessation over a short term period of SCL wear.

Hypothesis: It was expected that endothelial parameters in full-time hydrogel SCL wearers would be more unstable after two weeks SCL wear cessation than SH SCL wearers or NCL wearers.

METHODS

- Inclusion criteria:
  - Myopic prescriptions with low astigmatism (< -2.00 DC)
  - No systemic or ocular disease
  - SCL group: Full-time SCL wear (>5 days per week for at least one year).
  - NCL group: no history of CL wear in the year prior to enrolment.

- Data collection:
  - Visits: baseline (SCL group: immediately following SCL removal), following SCL cessation on day 1, 2, 7 & 14. NCL control subjects were asked to attend the clinic at the same time intervals. Appointments were scheduled at the same time of day (± 2 hours) to limit the possible influence of diurnal variation.
  - Endothelial specular microscopy: 7 areas of the endothelium were analysed centrally (para-centrally 0.6mm from centre) at 0°, 90°, 180°, 270° and the superior and inferior periphery (3.7mm from centre) (Figure 1 and 2).

RESULTS

- Statistical analysis:
  - SPSS 22 was used for statistical analysis. Normality for continuous data was assessed using the Shapiro-Wilk method. Two-way ANOVA parametric testing was used for comparisons of groups. P < 0.05 was considered statistically significant.

   - Two-way ANOVA testing demonstrated no significant effect of SCL material on central endothelial parameters of ECD (p = 0.36), CV (p = 0.20), hexagonality (p = 0.44) or MCA (p > 0.88) (Figures 3, 4, 5 and 6).
   - Two-way ANOVA and post-hoc Scheffe testing revealed that each SCL material had a significant effect on the CV para-centrally at 10°, with G2SHS wearers showing increased CV compared to G2BSH wearers. The CV at the superior peripheral location was significantly lower in the NCL compared to the hydrogel SCL group. The MCA in the inferior periphery was significantly higher in the NCL group compared to the hydrogel SCL group (Table 1).

- The influence of SCL material worn on the stability of endothelial parameters following 2 weeks SCL cessation was analysed. No significant differences between the SCL material and NCL control groups were found (two-way ANOVA, all p-values > 0.05).

CONCLUSIONS

- The various SCL materials examined do not have a significant effect on the central endothelial parameters compared to the NCL control group. However, SCL wear had a significant effect on peripheral corneal endothelial measurements in SCL wearers compared to NCL wearers, with the largest significant differences seen between NCL and hydrogel SCL groups.

- Results of this study are in agreement with those of Amam et al. (2003) who found increased peripheral ECD in SCL wearers compared to NCL wearers6. Amarn et al. proposed this was due to a redistribution of endothelial cells towards the periphery in SCL wear. However, we found a significantly reduced MCA in SCL wearers compared to NCL wearers. This reduced MCA would also account for the higher density of cells in the periphery.

- Following two weeks SCL cessation, there was no significant differences in the stability of all endothelial measurements, regardless of which SCL material was worn prior to SCL cessation.

Table 1: Endothelial parameters for the SCL material and NCL groups at baseline

<table>
<thead>
<tr>
<th>Parameter</th>
<th>NCL (n = 26)</th>
<th>G2SHS (n = 8)</th>
<th>G2BSH (n = 8)</th>
<th>Hydrogel (n = 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV at 10° (µm²)</td>
<td>27.67 ± 3.78</td>
<td>32.4 ± 3.8</td>
<td>26.9 ± 3.7</td>
<td>30.7 ± 5.2</td>
</tr>
<tr>
<td>CV at 90° (µm²)</td>
<td>26.9 ± 3.7</td>
<td>32.4 ± 3.8</td>
<td>26.9 ± 3.7</td>
<td>30.7 ± 5.2</td>
</tr>
<tr>
<td>CV at 180° (µm²)</td>
<td>26.9 ± 3.7</td>
<td>32.4 ± 3.8</td>
<td>26.9 ± 3.7</td>
<td>30.7 ± 5.2</td>
</tr>
<tr>
<td>CV at 270° (µm²)</td>
<td>26.9 ± 3.7</td>
<td>32.4 ± 3.8</td>
<td>26.9 ± 3.7</td>
<td>30.7 ± 5.2</td>
</tr>
<tr>
<td>CV at superior peripheral (µm²)</td>
<td>26.9 ± 3.7</td>
<td>32.4 ± 3.8</td>
<td>26.9 ± 3.7</td>
<td>30.7 ± 5.2</td>
</tr>
<tr>
<td>CV at inferior peripheral (µm²)</td>
<td>34.6 ± 5.8</td>
<td>38.3 ± 6.4</td>
<td>34.6 ± 5.8</td>
<td>38.3 ± 6.4</td>
</tr>
<tr>
<td>MCA at inferior periphery</td>
<td>533.0 ± 69.8</td>
<td>453.0 ± 69.8</td>
<td>533.0 ± 69.8</td>
<td>453.0 ± 69.8</td>
</tr>
<tr>
<td>MCA at superior periphery</td>
<td>533.0 ± 69.8</td>
<td>453.0 ± 69.8</td>
<td>533.0 ± 69.8</td>
<td>453.0 ± 69.8</td>
</tr>
</tbody>
</table>

- Statistically significant results of two-way ANOVA analysis are displayed in shaded cells (p < 0.05).

References:
3. FDA, USA. 2014. Medical devices. Products and medical devices: worries and the upturn direction. Services (141, Fig. 6) October 3, 2014. Silver Spring, MD.

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