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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 cessation of SCL wear.

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: 21.14 ± 2.85 years, p = 0.58). Parameters analysed were endothelial cell density (ECD; cell/mm²), mean cell area (MCA; μ²), coefficient of variation (COV) and hexagonality (%).

RESULTS: Prior to SCL cessation, two-way ANOVA testing showed significant differences between silicone hydrogel (SiH) SCL materials for the COV at 0°, with generation 2 SiH (G2SiH) wearers showing increased COV (27.67 ± 3.78) compared to generation 3 SiH (G3SiH) wearers (24.50 ± 3.73, p = 0.01). COV at the superior periphery was significantly lower in the NCL group (25.63 ± 2.79) compared to the hydrogel group (29.92 ± 6.22, p = 0.02). 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 = 0.02).

Following 14 days SCL cessation, 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 cessation, there were no significant differences in the stability of all endothelial measurements, regardless of which SCL material was worn.

BACKGROUND

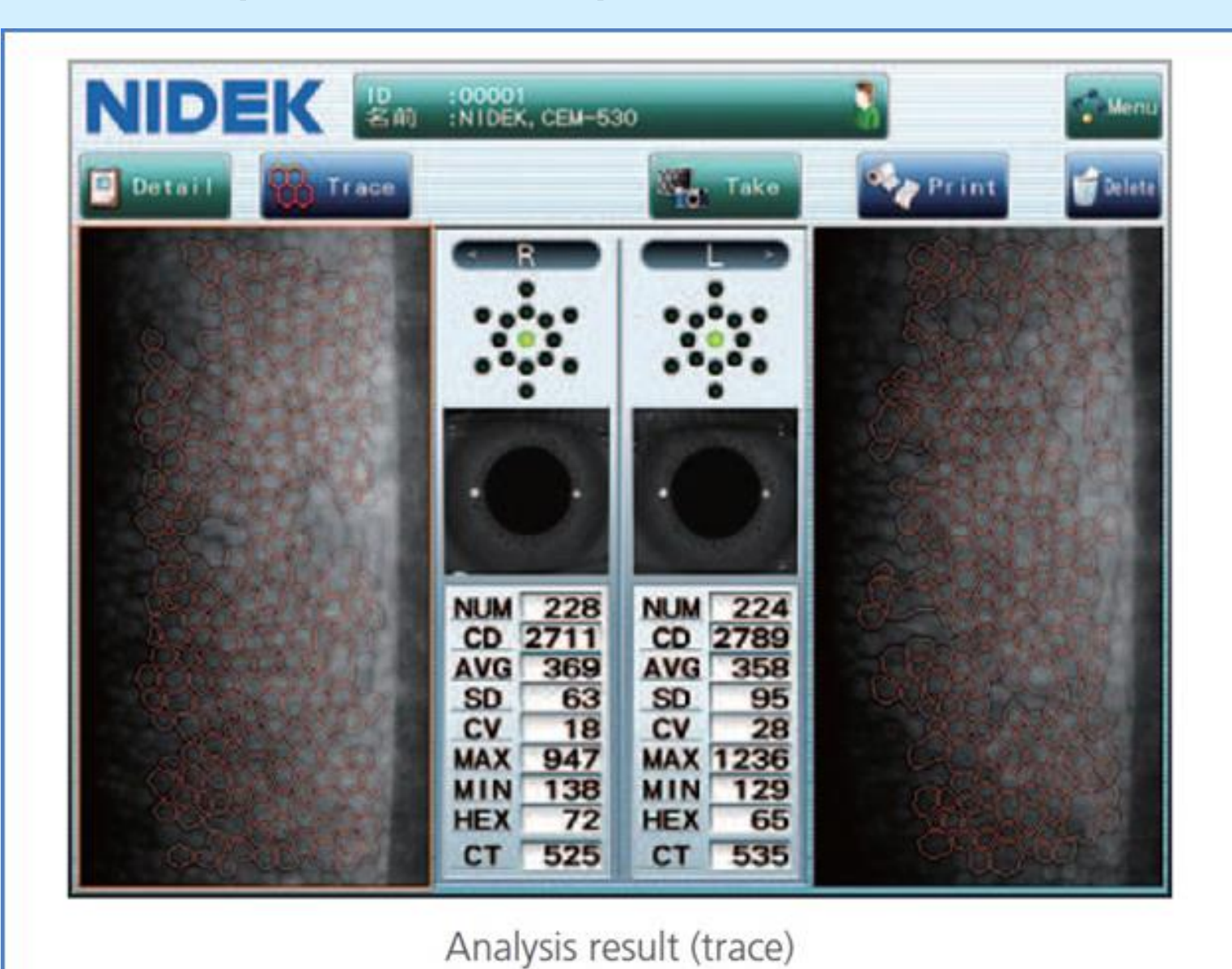
Corneal hypoxia due to over-wear of low oxygen transmissibility (DK/t) SCLs results in endothelial polymegathism and corneal thinning¹. High DK/t SiH materials are reported to have negligible effects on the corneal endothelium².

Hypothesis: endothelial parameters would show greater variation in a full-time low DK/t hydrogel SCL wearing group compared to a high DK/t SiH wearing group or NCL control group.

Refitting previous low DK/t CL wearers with higher DK/t CLs results in reversal of hypoxia-induced endothelial changes². 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 oedema-induced increased corneal thickness². 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 cessation time prior to corneal refractive surgery³ and it has been previously demonstrated⁴ that the resolution of corneal and curvature and thickness following SCL cessation occurs within this time.

Hypothesis: it was expected that endothelial corneal parameters in full time hydrogel SCL wearers would be more unstable after two weeks SCL wear cessation than SiH SCL wearers or NCL wearers

Figure 1: Corneal endothelial data captured by the CEM-530 specular microscope



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.

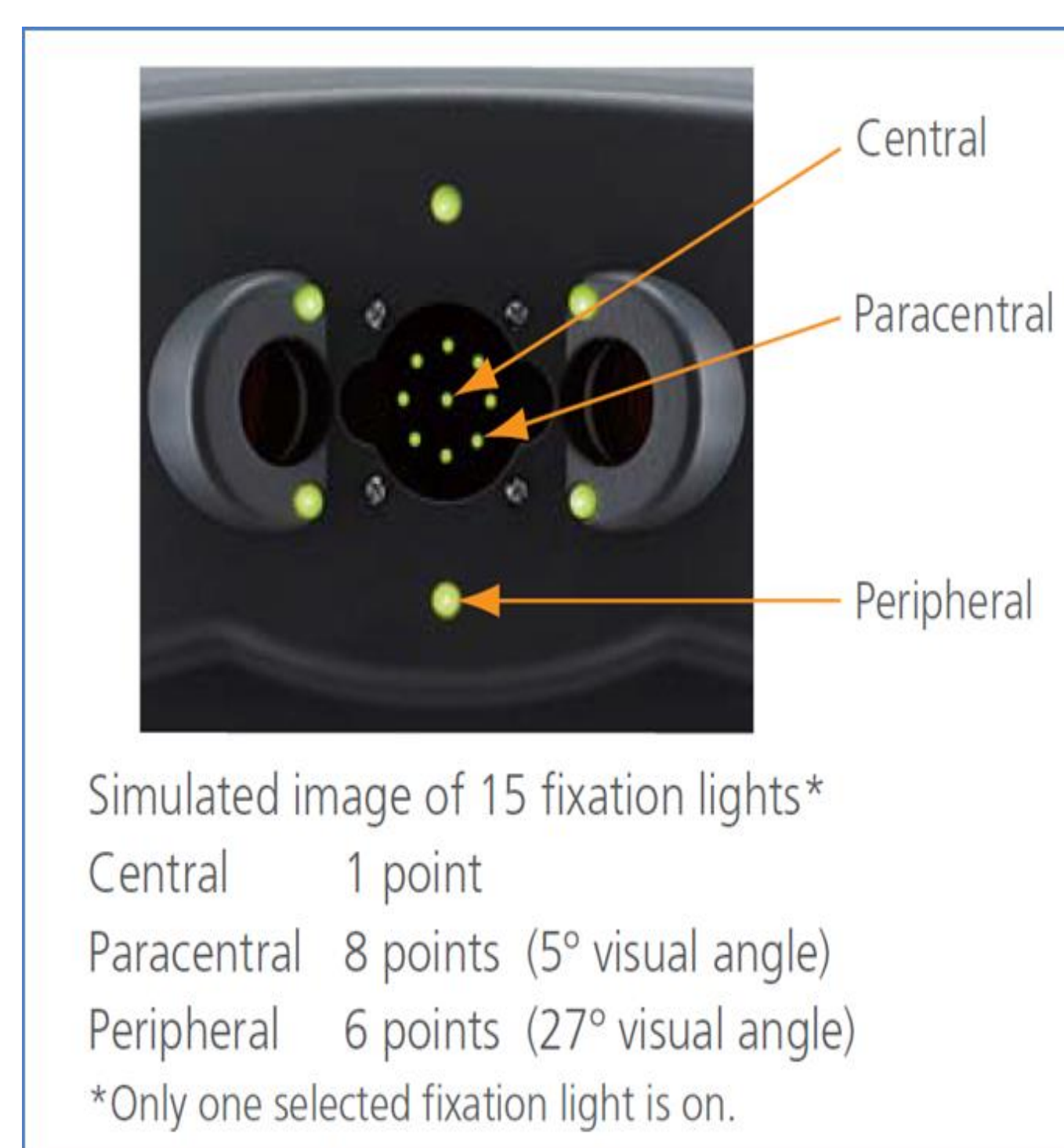
Data collection

- 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).

Statistical analysis

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

Figure 2: Corneal points captured by the CEM-530 specular microscope



RESULTS

- Two-way ANOVA testing demonstrated no significant effect of SCL material on central endothelial parameters of ECD (p = 0.36), COV (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 SCL material had a significant effect on the COV paracentrally at 0°, with G2SiH wearers showing increased COV compared to G3SiH wearers. The COV 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 wearers were found (Two-way ANOVA; all p-values > 0.05).

RESULTS

Figure 3: Endothelial cell density analysed for the SCL material groups at baseline

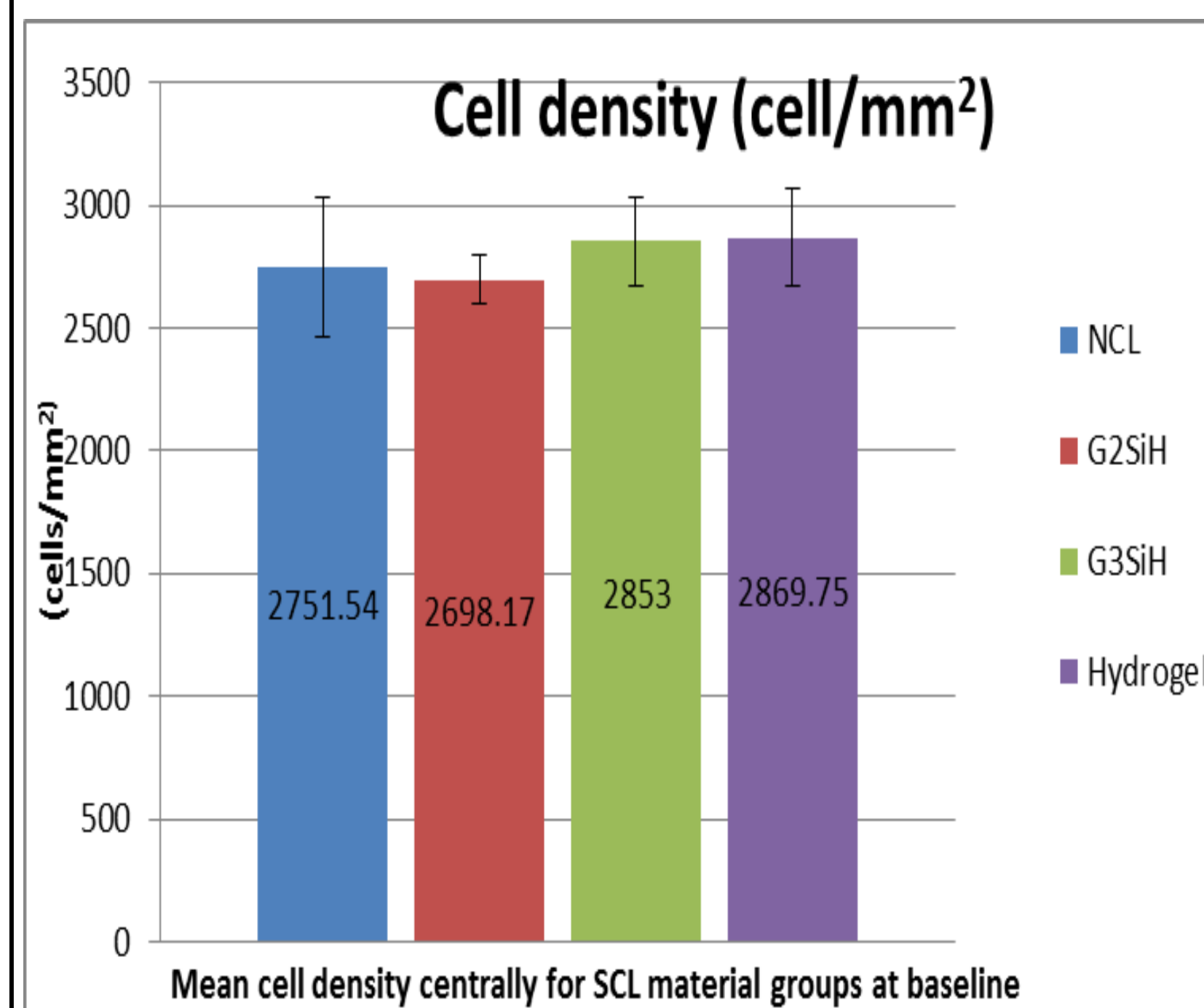


Figure 4: Coefficient of variation of endothelial cell size analysed for the SCL material groups at baseline

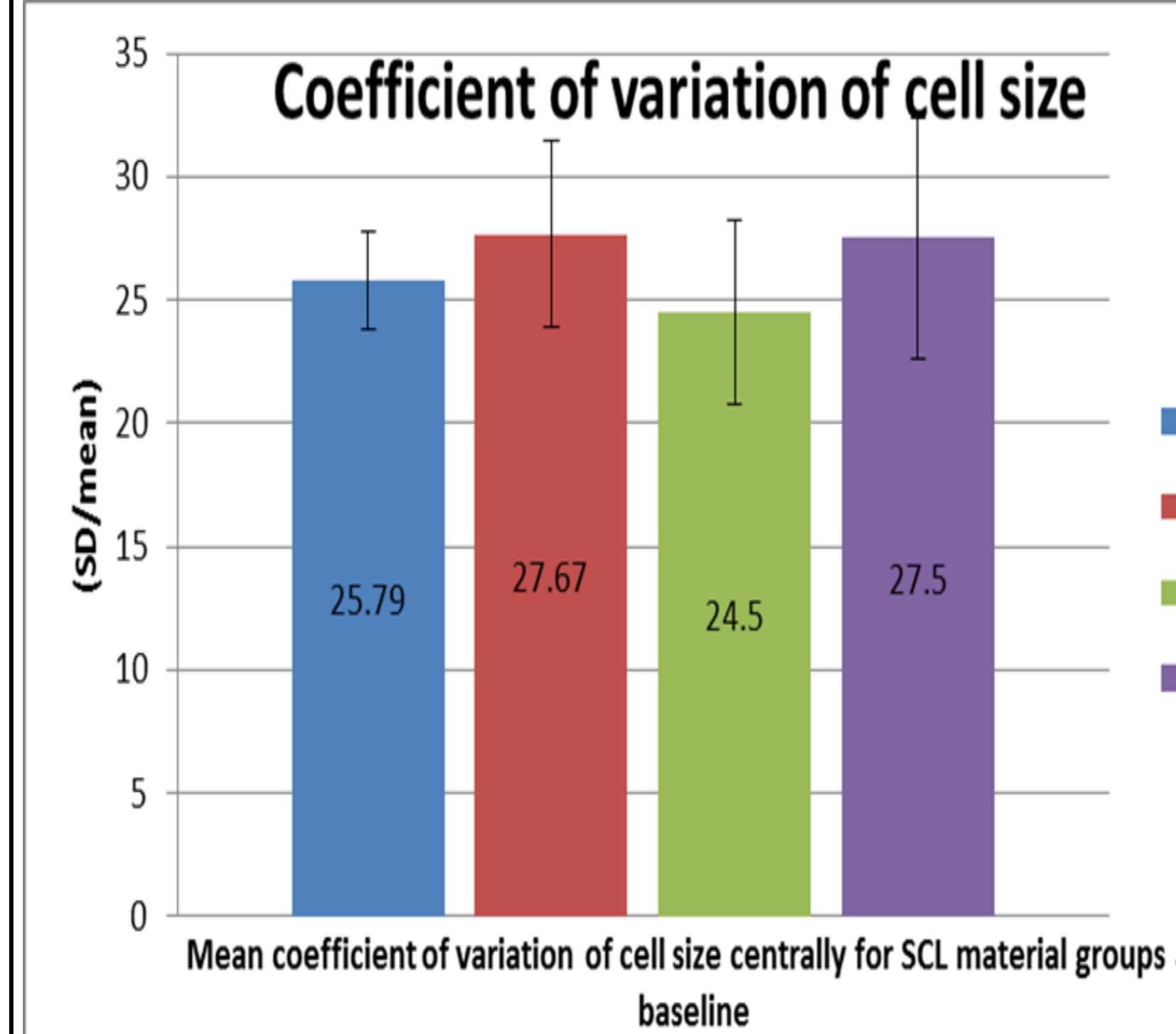


Figure 5: Endothelial cell hexagonality analysed for the SCL material groups at baseline

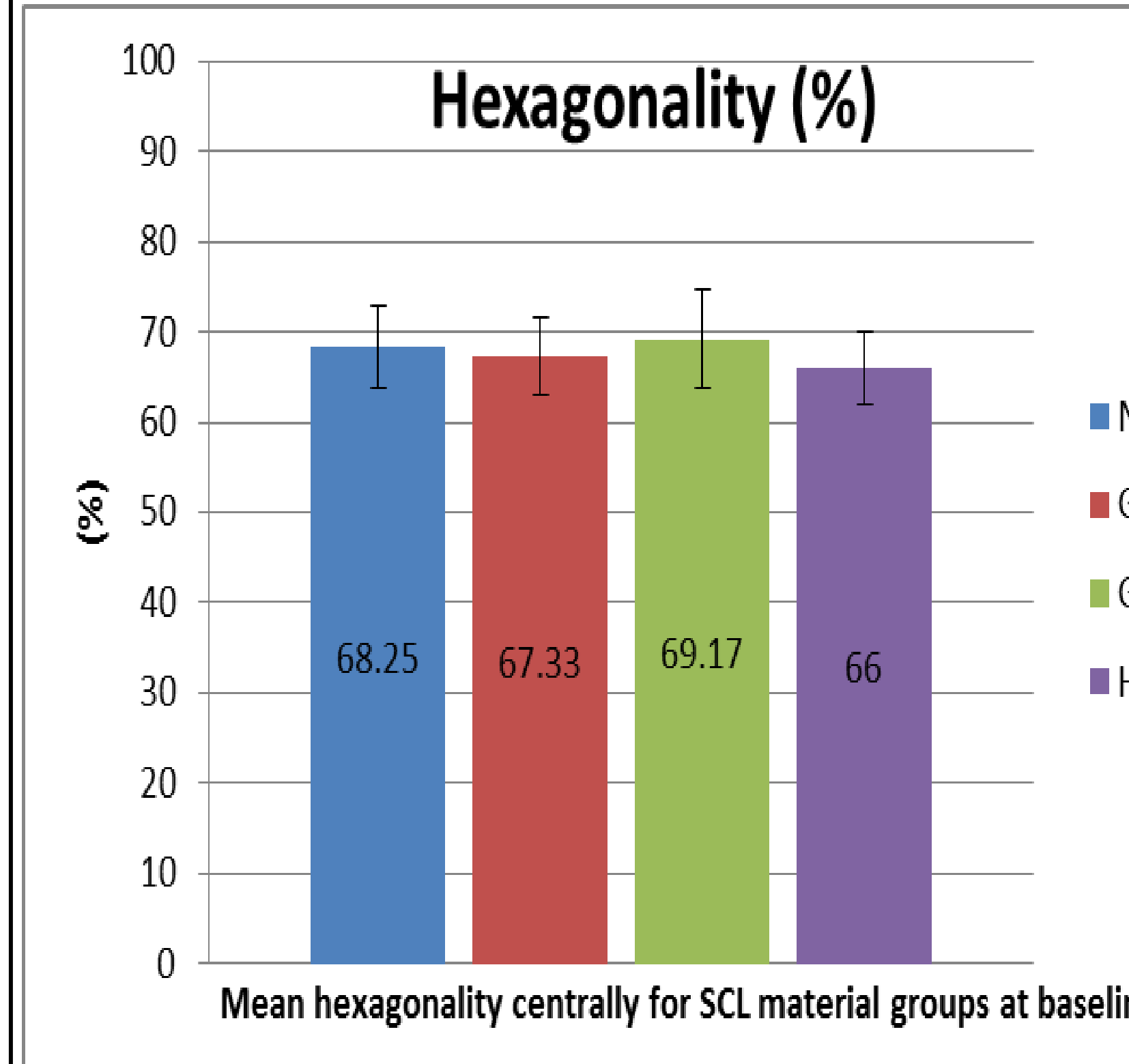


Figure 6: Mean endothelial cell area analysed for the SCL material groups at baseline

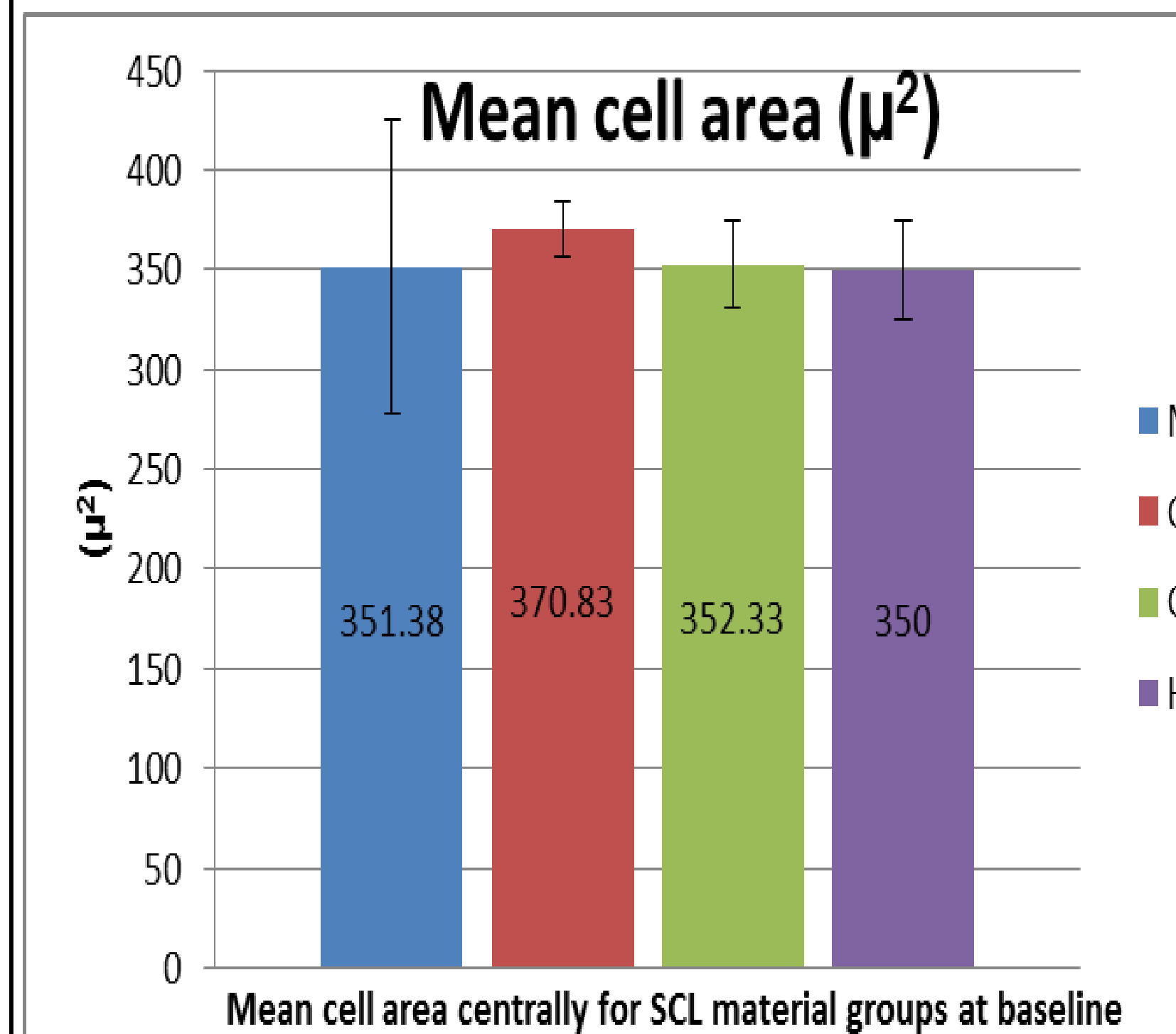


Table 1: Endothelial parameters for the SCL material and NCL groups at baseline.

SCL Groups:	Mean ± SD	ANOVA Sig	Scheffe Post hoc tests Sig
NCL (n = 28), G2SiH (n = 6), G3SiH (n = 6), Hydrogel (n = 19)			
COV at 0° (SD/mean)	NCL: 25.79 ± 2.00 G2SiH: 27.67 ± 3.78 G3SiH: 24.50 ± 3.73 Hydrogel: 27.50 ± 4.87	0.01	G2SiH and G3SiH Sig = 0.04
COV at superior periphery (SD/mean)	NCL: 25.63 ± 2.79 G2SiH: 29.33 ± 2.88 G3SiH: 27.33 ± 4.23 Hydrogel: 29.92 ± 6.22	0.02	Hydrogel and NCL Sig = 0.04
MCA at inferior periphery (μ ²)	NCL: 346.92 ± 36.75 G2SiH: 331.33 ± 11.69 G3SiH: 327.83 ± 11.84 Hydrogel: 314.92 ± 16.57	0.02	Hydrogel and NCL Sig = 0.03
ECD at inferior periphery (cells/mm ²)	NCL: 2935.08 ± 352.78 G2SiH: 3019.33 ± 109.11 G3SiH: 3052.00 ± 109.47 Hydrogel: 3184.08 ± 161.84	0.10	

Statistically significant results of two-way ANOVA analysis are displayed in shaded cells (p < 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 Amann et al. (2003) who found increased peripheral ECD in SCL wearers compared to NCL wearers⁵. Amann 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.

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