The Effect of Overnight Contact Lens Wear on the Human Tear Film

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INTRODUCTION

- A stable tear film is necessary to protect against ocular surface damage.
- Reductions in tear film lipid layer thickness during the daytime wear of soft and rigid contact lenses lead to an increase in aqueous tear layer evaporation and dry-eye symptoms.[1,2]
- A recent study showed that overnight wear of reverse-geometry lenses (RGL) did not produce signs or symptoms of dry eye.[3] In addition, patients suffering from mild dry eye report anecdotally the relief of symptoms following the overnight wear of RGLs.
- Amelioration of dry eye symptoms might be the result of reduced corneal sensitivity during RGL wear.[4] Alternatively, lens-induced changes to tear film composition during and immediately following the removal of lenses worn overnight[5,6] may produce improvements in tear layer stability and hence reduction in dry eye symptoms.

PURPOSE

- To examine the changes to the human tear film after a single overnight wear of RGLs, compared to conventional rigid gas-permeable (RGP) and soft (SCL) contact lenses.

METHODS

SUBJECTS

- 18 adult subjects (6M, 12F; mean age: 22 yrs, range 18-33yrs) with good ocular health.
- RGP lens wearers excluded, SCL wearers refrained from lens wear for 7 days prior to study participation.

STUDY PROTOCOL

- Corneal topography and tear film parameters measured at baseline and after a minimum 8 hours of closed eye lens wear. Measurements taken 2 hours after eye opening and lens removal.
- Each subject wore 3 lens types (RGL, RGP, SCL) in random order on 3 separate occasions, in the non-dominant eye only.
- Minimum of 7 nights wash-out period between wear of each lens type.

LENSES

- RGL: BE reverse-geometry lenses (Boston XO material, plano, Capricornia Contact Lens, Brisbane, Australia), fitted according to manufacturer's guidelines to target approximately 2.00D reduction in myopia.
- RGP: J-Contour quadracurve spherical lenses (Boston XO material, -3.00D BVP, Capricornia Contact Lens), fitted in alignment with cornea using standard techniques.
- SCL: Acuvue Advance (Galyfilcon A, +3.00D BVP, J&J Vision Care, Jacksonville, USA), fitted using standard techniques.
- Lens center thickness ordered to achieve a similar lens Dk/t of ~50 ISO units across all 3 lens types.

STUDY MEASUREMENTS (non-dominant eye only)

- Measurements conducted by masked investigator.

Corneal topography

- Medmont E300 (Medmont Pty Ltd, Melbourne, Australia).
- Variable of interest: apical radius of curvature r_o (mm).

Ocular Tear film Parameters

- Tear film lipid layer thickness (LipiView interferometer; TearScience Inc., Morrisville, USA).
- Non-invasive keratograph tear break-up time (Oculus Keratograph; Oculus, Arlington, USA)
  - Three independent measurements taken at each visit.
- Lower tear meniscus height (Oculus Keratograph)
  - height measured using instrument's caliper tool.

STATISTICAL ANALYSIS

- RM-ANOVA and post-hoc t-tests protected by Bonferroni correction to compare post-wear to baseline measurements.
- Spearman's correlation to investigate the association between variables.
- Critical p-value of 0.05 to denote statistical significance.

RESULTS

- There was a significant change in corneal topography following lens wear (p=0.002, RM-ANOVA) (Figure 1). Corneal apical radius increased from baseline (0.10±0.11mm, p=0.014, post-hoc paired t-test) following overnight wear of RGLs.
- There was no significant change from baseline in lipid layer thickness (Figure 2) or lower tear meniscus height (Figure 3) following the overnight wear of each lens type (all p>0.05, RM-ANOVA).
- Analysis of non-invasive keratograph tear break-up time measurements from all visits showed the first reading was significantly lower than the second (p=0.02, paired t-test; bias = 1.55 seconds). The correlation of repeatability for within-visit measurements was ±10.6 seconds using Bland-Altman analysis (Figure 4). Consequently, only the first measurement was used for subsequent analysis. There was no significant change from baseline in non-invasive keratograph tear break-up time (Figure 5).
- There was a significant correlation between changes from baseline in corneal apical radius and non-invasive keratograph tear break-up time, and between changes from baseline in corneal apical radius and lower tear meniscus height, following overnight wear of RGLs (Table 1).

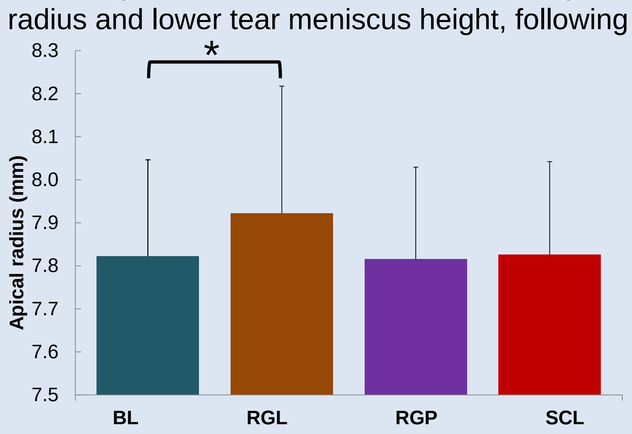

Figure 1: Corneal apical radius at baseline (BL) and following single overnight wear of reverse-geometry (RGL), rigid gas-permeable (RGP) and soft (SCL) contact lenses. Error bars represent one standard deviation. *denotes statistical significance at the 0.05 level.

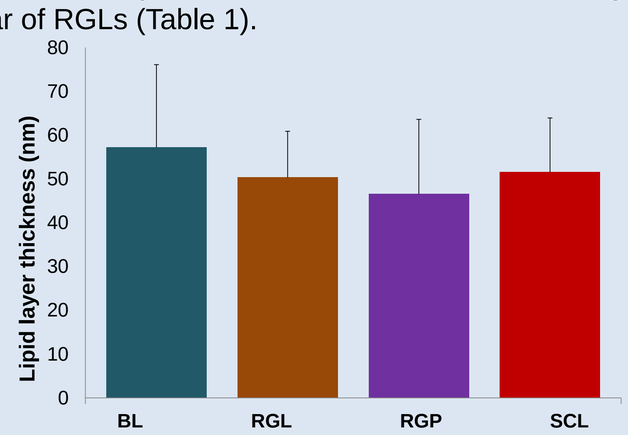

Figure 2: Lipid layer thickness at baseline (BL) and following single overnight wear of reverse-geometry (RGL), rigid gas-permeable (RGP) and soft (SCL) contact lenses. Error bars represent one standard deviation.

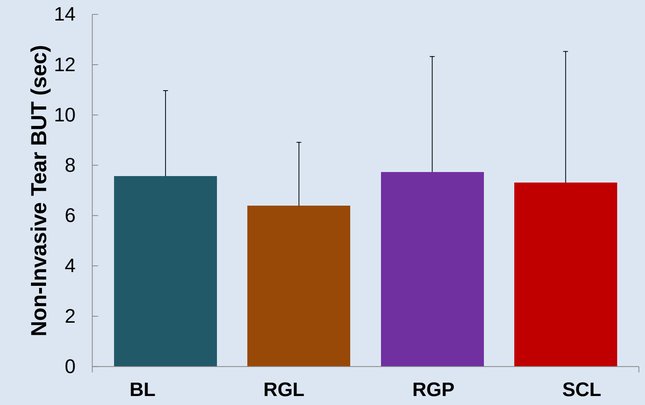

Figure 3: Lower tear meniscus height at baseline (BL) and following single overnight wear of reverse-geometry (RGL), rigid gas-permeable (RGP) and soft (SCL) contact lenses. Error bars represent one standard deviation.

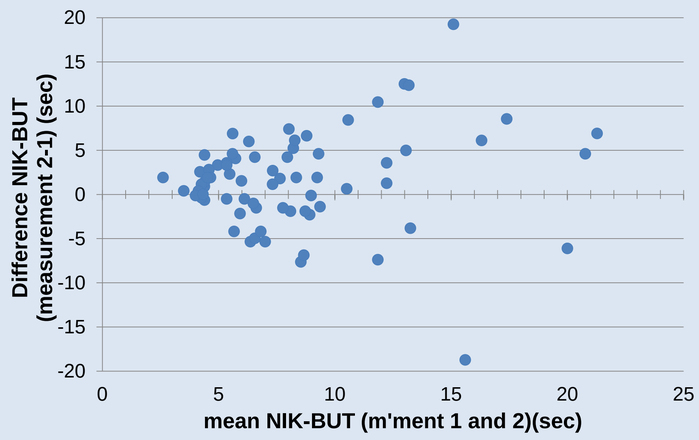

Figure 4: Bland-Altman plot comparing the means and differences between the first and second measurements of non-invasive keratograph tear break-up time (NIK-BUT) taken at all visits for all subjects (n=72).

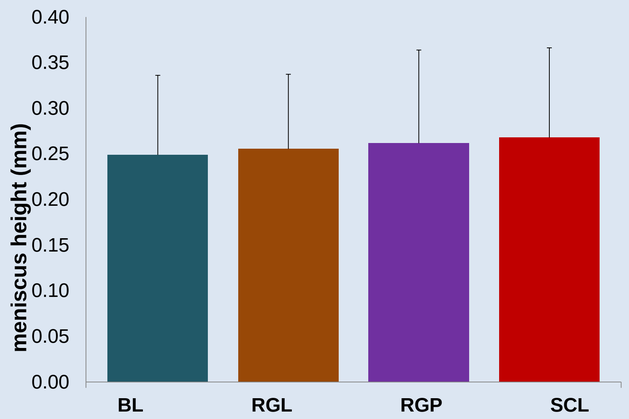

Figure 5: Non-invasive keratograph tear break-up time at baseline (BL) and following single overnight wear of reverse-geometry (RGL), rigid gas-permeable (RGP) and soft (SCL) contact lenses. Error bars represent one standard deviation.

Change from baseline		Non-invasive tear break-up time	Lipid layer thickness	Meniscus height
Apical radius	RGL	***r_s = 0.552*** ***p = 0.018****	*r_s = 0.047* *p = 0.855*	***r_s = 0.574*** ***p = 0.013 ****
	RGP	*r_s = -0.131* *p = 0.641*	*r_s = 0.222* *p = 0.392*	*r_s = 0.420* *p = 0.093*
	SCL	*r_s = 0.027* *p = 0.924*	*r_s = -0.020* *p = 0.936*	*r_s = -0.162* *p = 0.512*

Table 1: Correlations (Spearmans' coefficient) between change from baseline in corneal apical radii and tear layer parameters following single overnight wear of reverse-geometry (RGL), rigid gas-permeable (RGP) and soft (SCL) contact lenses.

DISCUSSION

- Although a single overnight wear of RGLs produced a significant change (flattening) in corneal apical radius (Figure 1), this did not produce significant changes in either lipid layer thickness (Figure 2), lower tear meniscus height (Figure 3), or non-invasive keratograph tear break-up time (Figure 5).
- Further analysis using a Bland-Altman plot shows large variability for the non-invasive keratograph tear break-up time measurements (Figure 4), particularly for higher values. This is consistent with a recent study by Cox et al[7] and suggests poor repeatability of the Oculus Keratograph for assessing non-invasive tear break-up time.
- Interestingly, moderate correlations were found between change from baseline in corneal apical radius and both non-invasive keratograph tear break-up time and lower tear meniscus height, following the overnight wear of RGLs (Table 1). This suggests that increased corneal flattening from overnight RGL wear may be associated with enhanced tear film stability. Further investigations are indicated.

CONCLUSIONS

- A single overnight wear of contact lenses does not significantly alter the lipid layer thickness, non-invasive keratograph tear break-up time, or lower tear meniscus height in the human tear film.
- Limitations in the instrumentation used may have contributed to large variability in primary results, leading to non-significant findings.
- Correlations between corneal topography change and both non-invasive keratograph tear break-up time and lower tear meniscus height change may indicate enhanced tear film stability following overnight wear of RGLs.

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