CHARACTERIZING CORNEAL CHANGES INDUCED BY ORTHOKERATOLOGY USING HIGH RESOLUTION OCT: 1998 REVISITED

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INTRODUCTION

Orthokeratology (OK) involves overnight wear of reverse geometry rigid contact lenses that temporarily reshape the anterior cornea to correct mild to moderate degrees of myopia2,3. Early research, conducted in the late 1990s, suggested that corneal curvature changes induced by OK lens wear resulted from reorganisation of anterior corneal tissue (primarily thinning of central epithelium and thickening of paracentral stroma) rather than overall corneal bending4,5. Based on Munnerlyn’s formula4 it was proposed that refractive changes induced by overnight OK can be completely explained by these topographical changes in thickness6,7,8. This conventional view of OK refractive effects was based on the superseded technology of optical pachymetry, and has been challenged by some who consider that stromal bending may play a significant role in OK effects8. Therefore, we sought to re-investigate this conventional explanation of OK effects using advanced technology that allows high-resolution imaging of corneal tissue across a large scan width.

PURPOSE

To investigate changes in epithelial and stromal corneal thickness along the horizontal and vertical meridians after overnight OK lens wear using a high resolution Tomey CASIA optical coherence tomographer (OCT).

METHODS

SUBJECTS

• 28 young adult subjects (age range 18-26 years)
• Inclusion criteria – ≤± 3.00D and ≤± 1.00DC
• No prior rigid gas-permeable contact lens wear
• Good ocular health and no contraindications for OK lens wear
• Both eyes fitted with the same OK lenses (Paragon CRT; Paragon Vision Sciences, Inc., USA) made from HDS 100 material
• Measurements taken at baseline and after 4 weeks overnight OK lens wear within 2-3 hours after lens removal

MEASUREMENTS

• Distance LogMAR visual acuity (VA) (Test Chart Pro, Thorston Software Solutions, UK)
• Central objective refraction (Shin-Nippon NVision K-9000 autorefractor; Japan)
• Average of 5 measurements, converted to vector components M, J0, & J4
• Corneal topography (Medmont E90; Australia)
• Average of 4 measurements
• Anterior eye OCT (Tomey CASIA, Japan)
• 17μm scan width, 1904 scans per measurement
• 3-4 corneal recordings/measurements taken along the horizontal & vertical meridians
• Epithelial, stromal and total corneal thickness measurements at center (vertical), 0.25, 0.5, 1, 1.5, 2 and 2.5mm from center

STATISTICAL ANALYSIS

• Data taken from one eye only
• Linear Mixed Model analysis of ANOVA or Friedman test with post-hoc t-tests to analyze changes in vision, central refraction, epithelial, stromal and full corneal thickness. Critical p-value ≤0.05

RESULTS

DISTANCE VA

There was no significant difference between best corrected distance VA measured at baseline (-0.05 ± 0.05) and after 4 weeks of OK lens wear (-0.05 ± 0.05) (p > 0.38).

CENTRAL REFRACTION

Measurements taken at baseline and after 4 weeks of OK lens wear are shown in Table 1. There was a significant hypopnic M shift and no change in astigmatism.

CORNEAL TOPOGRAPHY

• Apical radius of curvature (R0), and Flat and Steep K before and after OK lens wear are shown in Table 2
• There was significant corneal flattening reflected by a significant increase in R0 and decrease in both Flat K and Steep K values.

EPITHELIAL THICKNESS CHANGES

OK lens wear induced significant changes in epithelial thickness along both the horizontal and vertical meridians.

• There was significant thinning of the epithelium in the central cornea and epithelial thickening in the paracentral cornea (Figure 1).

STROMAL THICKNESS CHANGES

• There were significant changes in stromal thickness across the horizontal and vertical meridians.
• There was significant thickening of the stroma as shown in Figure 2.

TOTAL CORNEAL THICKNESS CHANGES

• Significant changes in overall corneal thickness along the horizontal and vertical meridians.
• There was significant decrease in central corneal thickness and increased thickness in the paracentral cornea.

DISCUSSION

• In agreement with previous studies, overall corneal thickness decreased in the center and increased in the paracentral cornea along both the horizontal and vertical meridians,9,10.
• Decrease in central corneal thickness is mostly due to thinning of the central epithelium and increase in paracentral corneal thickness is due to increase in both epithelial and stromal thicknesses9,7,8.
• Some studies have found stromal thickening centrally,9,10 while others have reported no change.9 Increase in stromal thickness across the cornea is likely to be a result of residual hydropic edema.
• Applying Munnerlyn’s formula4 to corneal sag height change (55-158μm) measured across a 3mm corneal chord and a corneal refractive index of 1.37, the anticipated refractive power change was 1.9GJ. This is very similar to the measured refractive power change (1.93μGJ) indicating that corneal sagittal height change due to corneal thickness changes can account for refractive changes induced by OK.

CONCLUSIONS

• Central corneal thinning induced by OK was mostly due to epithelial thinning.
• Mid-peripheral corneal thickening was a combination of epithelial and stromal thickening.
• Central corneal thickness changes can account for refractive changes, further supporting the hypothesis that OK induces its refractive effects through anterior corneal changes rather than overall corneal bending.

REFERENCES


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