Evaluation of clinical performance of a new reverse-geometry contact lenses for overnight orthokeratology: pilot study

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Introduction

Orthokeratology (OK) is a clinical technique that uses specially rigid contact lenses designed to modify the central cornea and temporarily reduce myopia. Investigations on OK have found also its positive effect on myopia control. Its effect is associated to central thickness and curvature changes and increase of corneal and ocular high order aberrations (HOAs).1-4 When broken down into constituent Zernike components, the increase in HOA has been shown to be predominantly attributable to an increase in coma-like aberrations and a positive shift in spherical aberration (SA).5,6 Positive shifts in spherical aberration (SA) may reduce induced accommodative lag with OK, and this has been proposed as possible factor involved in reduced myopia progression.7 Orthokeratologic treatment introduce a modification of peripheral refraction also leaving peripheral myopic blur.10,11 This further effect acts as a cue that could potentially slow the progression of myopia too.12 Also alteration of corneal biomechanical properties seem related to short term OK.13-15 These properties are presented like corneal hysteresis (CH), which is defined as a measure of viscous damping of the corneal tissue or the energy absorption capability of the cornea, and corneal resistance factor (CRF), which is the viscoelastic resistance to an applied force. CH and CRF measurements are repeatable in OK patients16 and CH value seem related to a faster response/regression in short term.14 The purpose of this pilot study is to investigate the effect of overnight orthokeratology contact lens wear after a period of 1 month in a group of new contact lens wearers on: HOAs, peripheral refraction, and biomechanics of the cornea.

Methods

Twenty-four eyes of 12 myopic patients were fitted with Overnight reverse-geometry contact lenses for overnight orthokeratology (Softex, D.N Misgav, Israel) realized in Contamac Optimum Extra 100X1011 DK (Fig.1). Corneal topography were measured using a cone based corneal topograph (Medmont E300- Medmont Pty Ltd, Brisbane, AU), ocular HOAs for a 4-mm pupil were measured with a Hartmann – Shack aberrometer (KR-1W, Topcon, Capelle, NL) and corneal biomechanical properties, including CH and CRF, were measured using a dynamic, bidirectional applanation process obtained with Ocular Response Analyser (ORA; Reichert Inc, Depew, US). The central and relative peripheral refractive error (RPRE) were measured also along the horizontal meridian up to 30 degrees of eccentricity in the nasal and temporal retinal area in 10° steps with an open field autorefractometer (NVision K5001, Shin-Nippon, Tokio,JP) and measurements were transposed into M, J0, and J45 vectors.17 Relative peripheral refractive error (RPRE) were calculated by subtracting M central refraction from peripheral M refraction values. All measurements were taken at pre-wear, and after 30 days of wear of the best fitted contact lenses after a minimum of 6 hours from awakening.

Results

All the subjects (5 male and 7 female) enrolled successfully complete the study the mean age was 28 ± 10.4 years, the spherical equivalent (SE) was -3.00 ± 1.39 D and astigmatism -0.52 ± 0.28 D. After one month visit, the mean SE was -0.12±0.25D with a reduction of 98% in respect to baseline value and with an unaided logMAR visual acuity of -0.04 ± 0.04 logMAR. Corneal biomechanics values didn’t change significantly (paired t-tests, p > 0.05). Average CH value before and after Overnight wear was 10.6±0.94 mmHg and 10.8±0.84 mmHg respectively, and for CRF 11.25±0.60 mmHg and 10.8±0.94 mmHg (Fig.2). The treatment with OK contact lenses induced a significant increase of ocular root mean square of HOAs (paired t-tests, p < 0.01) 0.125±0.054μm vs 0.228±0.088μm. Considering Zernike spherical aberration presented a significant positive shift (p < 0.01) 0.028±0.045μm vs 0.119±0.038μm and coma a significant increase (p < 0.05) 0.094±0.052 μm vs 0.181±0.096μm trefoil and tetrofoil didn’t change significantly (Fig.3). Considering peripheral refraction at baseline, subjects showed relative peripheral emmetropia compared with central refraction. One month of Overnight CLs wear produced significant myopic shifts in peripheral refraction starting from 10° in the temporal and nasal direction even though towards the temporal side the effect was more evident (Fig.4).

Conclusions

Contact lenses used for the study decreased safely and effectively the myopic refractive error at 1 month of wear. In this study CH was unaffected and CRF shows a decreasing trend although not statistically significant how found in other studies on this topic.13,14 The reduction of CRF measured suggesting that the cornea developed a tendency to rebound slightly faster and became less resistant to forces applied after treatment. Like in previous studies14 higher-order aberrations (HOAs), particularly spherical aberration and coma, increased significantly for effect of contact lens wear although their effect has not introduced reductions of corneal contrast VA. The lens wear induced a myopic defocus in the periphery useful to provide a potential mechanism for myopia control in myopic children.12

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References