Efficacy of a new lens for overnight orthokeratology (OK) in hyperopia and his implication in presbyopia

CENTRO MEDICO TEKNON

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INTRODUCTION

Orthokeratology describes the use of rigid contact lenses to reshape the corneal profile, temporarily modifying or eliminating refractive error.

Despite advances in materials and technolology, interest in hyperopic Orthokeratology (OK) from researchers and contact lens manufacturers have failed to reach the levels seen for myopic OK. Initial work was conducted by Swarbrick et al.[1] .The results lead the authors to suggest corneal molding as the primary factor driving corneal shape change. Notwithstanding good knowledge of the corneal shape response in myopic OK, the mechanisms driving these changes remain poorly understood such as how postlens tear film pressures may be influential in the corneal molding process.[2]

Although treatment appears to be effective for correcting hyperopia, it sometimes seems unpredictable. The amount of maximum change in spherical refraction is today unknown and leads to an increase of High Order Aberrations, especially if the treatment results in decentering, in that case it causes Coma-like aberration[3].

PURPOSE

1. To clinically evaluate the visual performance of a new lens design for orthokeratology treatment of hyperopia.
2. To know its implications on the correction of presbyopia.
3. To allow the development of new avenues towards more effective designs.

METHODS

Nine hyperopic and presbyopes adults (age between 32 to 52 years old) were fitted with experimental lens (DRLH, Paunevision, Barcelona, Spain) manufactured by Precilens (Precilens, Créteil, Paris, France) in order to mold their cornea and eliminate refraction (Hyperopia between +1,00 and +6,75 D and Cylinder under -1,00 D.). None of them were contact lens wearers. The subjects have used the lenses only overnight for 9 months. We assessed the changes from before to after treatment for refraction, visual acuity, keratometric data, apical radius, eccentricity and optical aberrations. Values were obtained from corneal topography (Keratron Scout, Optikon 2000, Roma, Italy).

RESULTS

Data from nine patients showed all an improvement in the refraction changing from 2.46 ± 1.51D. to 0.05 ± 1.43 D. (p <0.0001), that is almost the total mean refraction, Figure 9. The amount of the cylinder change was not significant, Figure 1, visual acuity remained stable at clinical level, Figure 2, (slightly reduction from 1.10 (20/22) ± 0,14 to 1.02 (20/20) ± 0.11) and addition for near in presbyopic subjects decreased from 1.56 ± 0.35 to 0.63 ± 0.40 D. (P <0.001) Figures 5 and 8. The total High Order Aberration (RMS) increased from 0,243 ± 0,212 to 0,385 ± 0,179 for a 4,5 mm pupil. Negative spherical aberration showed a significant increase of 0,101 ± 0,033 to -0,030 ± 0,149, P = 0.002, Figure 7, in correlation with the refractive change, R^2 = 0.61. The value of coma increased in all cases, allways in relation to the degree of decentering of the treatment area.

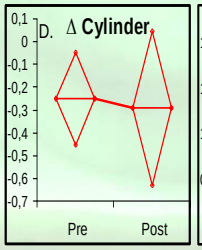

Figure 1. Change in Cylinder

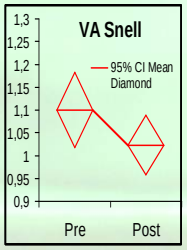

Figure 2. Change in BVCA (Decimal)

	n	Mean	95% CI		SD	p
Cylinder - Pre	12	-0,25	-0,45	to -0,05	0,32	0,652
Cylinder - Post	14	-0,29	-0,51	to -0,08	0,53	
Sphere - Pre	14	2,46	1,59	to 3,34	1,51	0.0001*
Sphere - Post	14	0,05	-0,77	to 0,89	1,43	
BCVA Snell - Pre	13	1,10	1,02	to 1,18	0,14	0,039*
BCVA Snell - Post	13	1,02	0,96	to 1,09	0,11	
BCVA LogMar - Pre	13	-0,04	-0,07	to -0,01	0,06	0,039*
BCVA LogMar - Post	13	-0,01	-0,03	to 0,02	0,04	
Add - Pre	8	1,56	1,27	to 1,85	0,35	<0.001*
Add - Post	8	0,63	0,29	to 0,96	0,40	

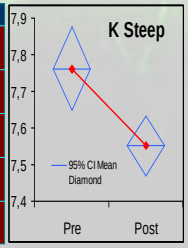

Figure 3. Change of the Keratometric flat radius

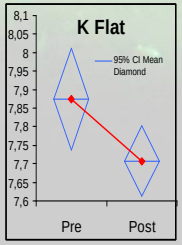

Figure 4. Change of the steep keratometric radius (mm.)

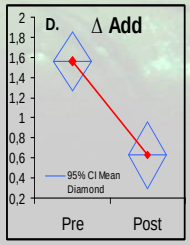

Figure 5. Change in Add

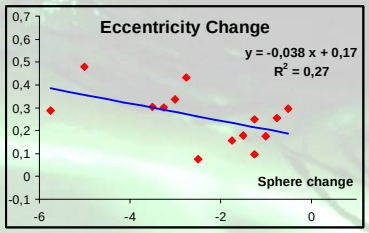

Figure 6. Relationship between eccentricity change and Sphere change

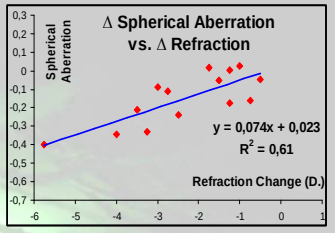

Figure 7. Correlation from Change in Spherical Aberration and Refraction

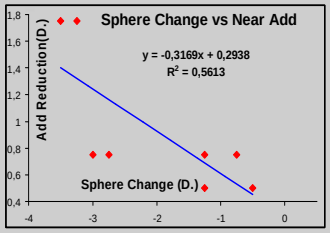

Figure 8. Relationship from refractive change at far and reduction of need Add for near

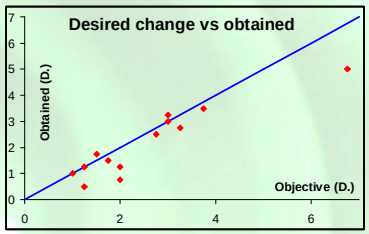

Figure 9. Plot represents obtained vs desired refraction change. The blue line means the target change

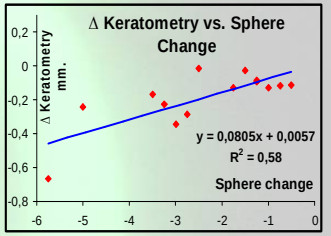

Figure 10. Relation from change of flat keratometry towards Sphere change.

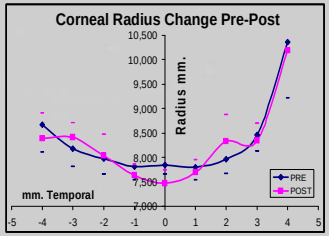

Figure 11. Example of case #8. corneal radius change in the horizontal meridian (mm.).

DISCUSION

The final value of spherical aberration is dependent from the steepening of the central radius and corneal eccentricity value. While the total aberration produces an slight reduction in visual acuity, only one patient expressed monocular diplopia at night, which disappeared once the lens was changed and replaced by a new one whit improved centering.

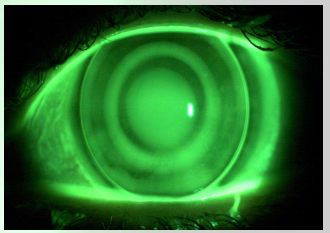

Figure 13. Case #8. Lens fluorogram

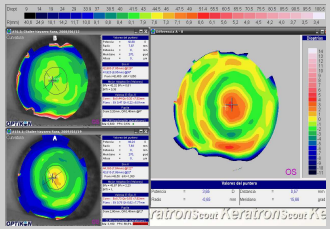

Figure 12. Case #8 . Topographic results

A surprising change of another refractive parameters was the improvement experienced in presbyopic subjects. These reduced the amount of needed addition to see at near, probably because the increase in negative spherical aberration, which creates a multifocal cornea. As a result, increased focal depth may be associated with the slight decrease of visual acuity for far. As the sample was reduced, it will be necessary a further research on the subject.

CONCLUSION

Lenses for corneal molding for the correction of hyperopia by shown to be effective. Refraction was totally corrected in most of the patients on the target. The cylinder shows a no significant change. The central cornea steepens and peripheral shows signs of thinning due to compression. The changes increases corneal eccentricity and therefore the negative spherical aberration. Although the HOA results increased it not seems that modify the visual acuity as much. On the contrary, like a side effect, the increased negative spherical aberration reduces the need for add at near, creating a multifocal cornea with centre for near, providing functional vision at all distances without glasses. The amount of the correction for presbyopia seems to be dependent from the total amount of hyperopia we correct.

REFERENCES

1.Gifford P. And Swarbrick H. Time Course of Corneal Topographic Changes in the First Week of Overnight Hyperopic Orthokeratology. *Optometry and Vision Science*, Vol. 85, No. 12, December 2008
2.Gifford et al. Mechanism for Corneal Reshaping in Hyperopic Orthokeratology. *Optometry and Vision Science*, Vol. 86, No. 4, April 2009
3. Lu et al. Corneal Shape and Optical Performance After One Night of Corneal Refractive Therapy for Hyperopia.*Optometry and Vision Science*, Vol. 84, No. 4, April 2007

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