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A Prospective Evaluation of Efficacy and Safety Profiles of the Novel Hiline Overnight Orthokeratology Contact Lens for the Temporary Reduction of Myopia

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Background: Orthokeratology is the programmed application of rigid gas-permeable contact lenses for the temporary reduction of myopia. New reverse geometry contact lens designs and materials have led to a renewed interest in this field. The purpose of this study was to evaluate efficacy and safety profiles of the Hiline orthokeratology contact lens in the temporary reduction of myopia when worn overnight. **Methods:** Eighty-two myopic subjects (161 eyes; 22 males and 59 females; mean age, 26.5 years, range 12 to 47 years) were recruited from the Tri-Service General Hospital and the Mackay Memorial Hospital. Subjects received a 36-week trial of overnight orthokeratology using reverse geometry rigid contact lenses (using Boston Equalens II (oprifocon A) lens material by DreamLens Inc.). The oxygen permeability was 85 by ISO/Fatt and each subject underwent a 4-week follow-up period after discontinuing wearing the lenses. After commencing lens wear, subjects were examined on day 1, weeks 1, 2, 4, 12, 24, and 36, and days 1, 7, and 28 after a final evaluation. Visual acuity was checked with the Snellen chart: autorefraction by the Nikon autokeratometer; corneal topography and corneal thickness with the Orbscan II; and slit-lamp examinations were performed to check the corneal condition at each session. Success was defined by improvement in uncorrected Snellen visual acuity of ≥ 2 lines with ≥20/40 unaided distance Snellen visual acuity at the final evaluation. **Results:** Sixty-four subjects (128 eyes) completed the study. The uncorrected visual acuity improved significantly by day 7. The success rate at the final evaluation was 100% in both eyes for all subjects and the most significant change occurred between day 1 and day 7. **Conclusion:** Hiline overnight orthokeratology is an effective way of temporarily reducing myopia. At the final visit, the success rates were 100%. The efficacy of the orthokeratology lens in reducing myopia was confirmed because the lower bound of the 95% confidence interval for subjects was greater than the prespecified 85%. Changes were more prominent in the first week after treatment, particularly on day 1, and reached a maximal effect in week 1. Visual acuity was not correlated to refractive changes. A possible explanation for this is that the autorefractor checks the paracentral cornea, whereas a subject sees through the more central and flatter regions of the cornea. Thinning of the corneal epithelium indicates that a possible mechanism of corneal remodeling is redistribution of the epithelium.

Key words: orthokeratology, myopia, reverse geometry contact lens

INTRODUCTION

It is well established that wearing rigid gas-permeable contact lenses can produce changes in corneal curvature[1]. Orthokeratology is the temporary reduction in myopia by the programmed application of rigid contact lenses. Specifically, flat-fitting rigid contact lenses produce reductions in myopia by flattening the corneal curvature.

The first large-scale investigation of orthokeratology was conducted by Kerns who compared subjects wearing flat-fitting poly(methyl methacrylate) (PMMA) contact lenses during the day with subjects wearing spectacles and subjects wearing conventionally fitted PMMA lenses. Orthokeratology contact lenses were 0.25 diopters (D) to 0.50 D flatter than the flatter keratometry reading.

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Although a reduction in myopia (mean change, 0.87 D) was observed[2], Kerns concluded that the procedure was unpredictable and uncontrollable because of the induced astigmatism[3,4,5]. Binder *et al*. compared subjects wearing flat-fitting PMMA contact lenses on a daily basis with patients wearing conventionally fitted PMMA lenses[6]. The orthokeratology lenses fit between 0.50 D and 2.75 D flatter than the flattest corneal meridian. Binder *et al*. concluded that the procedure resulted in inconsistent and unpredictable reductions in myopia (mean reduction, 1.37 D)[7]. The Berkeley Orthokeratology Study compared a group wearing flat-fitting PMMA contact lenses on a daily basis with a control group wearing conventional PMMA contact lenses[8]. The mean reduction of myopia in the orthokeratology group was 1.01 D compared with 0.54 D in the control group.

Advances in oxygen transmissibility (Dk/t) of rigid gas-permeable materials are further influencing the current practice of orthokeratology. Holden and Mertz[9] found that limiting corneal edema to levels occurring normally during sleep (i.e., 4% swelling) requires a contact lens to have a minimum oxygen transmissibility of 87 (cm✕ml O_2)/(sec✕ml✕mmHg). New generation materials may provide oxygen transmissibility values that meet or exceed these criteria, minimizing and perhaps eliminating hypoxic stress and corneal edema when worn overnight. The potential advantage of this approach is that as lenses are worn, the cornea is reshaped, and the level of myopia is reduced as the patients sleep.

Recently, Mountford[10] conducted a study of orthokeratology in which patients wore reverse geometry contact lenses overnight. Unlike the original technique of orthokeratology, Mountford reported more predictable, consistent, and sustained reductions in myopia (mean reduction, 2.19 D).

Hiline Optical Company, Ltd Taipei, Taiwan is devoted to researching and developing novel orthokeratology contact lenses for patients with myopia. The Hiline orthokeratology contact lens is made of FDA-approved Boston Equalens II (oprifocon A) lens material along with innovative techniques for producing the most suitable orthokeratology contact lenses for Taiwanese patients with myopia.

The purpose of this study was to evaluate the efficacy and safety profiles of the Hiline orthokeratology contact lens in the temporary reduction of myopia, when worn overnight. This study was to be conducted in a prospective and one-arm trial fashion. The study results are intended to be used as part of the dossiers for the application of this new medical device.

METHODS

Subjects

This study was approved by the Institutional Review Boards of the Tri-Service General Hospital and the Mackay Memorial Hospital.

Eighty-one myopic subjects (161 eyes) (22 males, 59 females; mean age, 26.38 years, range 12 to 47 years) were recruited from the Tri-Service General Hospital and the Mackay Memorial Hospital. Each subject received a 36-week trial of overnight orthokeratology using reverse geometry rigid contact lenses (Boston Equalens II (oprifocon A) lens material; (Polymer Technology Corp., Wilmington, MA, USA) with an oxygen permeability of 85 determined by the ISO/Fatt method and a 4-week follow-up period after discontinuing wearing the lens. Subjects were required to be at least 12 years old and no older than 62 years of age with a degree of myopia from -1.00 to -4.00 D, astigmatism ≤ -1.50 D, and have a best spectacle-corrected visual acuity (VA) of 20/40 or better.

Subjects had normal healthy eyes without the use of ocular medications. A normal eye was defined as having the following characteristics: no evidence of active infection involving the conjunctiva, lids, or adnexa; no evidence of structural abnormalities of the lids, conjunctiva, or adnexal tissue and minimal levels (Grade 2 or less), considered insignificant by the investigator, of tarsal-conjunctival abnormalities are permissible; a cornea that is clear with no edema, no staining, no opacities, and no more than a trace amount of corneal vascularization (i.e., all vessels extending < 1.5 mm from the limbus), as observed with slit-lamp examination; no iritis; and no herpes keratitis or other active ocular disease that would contraindicate lens wear or lessen the attainability of VA for this study (20/40 or better). Each subject or his/her legally acceptable representative signed a written informed consent form.

The exclusion criteria were as follows: subjects with a disease that may affect the eye or be exacerbated by wearing the testing article; subjects who had an allergy to ingredients in the study lens care solutions (such as mercury or thimerosal); subjects who were pregnant, lactating, or premenopausal subjects with childbearing potential not using a reliable contraceptive; subjects with another serious disease considered by the investigator to make them unsuitable to enter the trial; subjects who had participated in another investigational drug trial within the 4 weeks before entering this study; subjects who had had intraocular or corneal surgery; subjects with Schirmer's test (without anesthetic) results < 5 mm/5 min; subjects

with photopic pupil > 4.5 mm or scotopic pupil > 6.5 mm; subjects with an endothelial cell count < 2000 cells/mm^2 (test results obtained within 1 year before screening visit were acceptable); subjects who had used steroids or systemic medications that may significantly affect vision or healing, steroid eye medication, eye ointment, pupil-dilating eye drops (except for examination procedures) within the 2 weeks before entering the study; and subjects who had worn rigid contact lenses before entering the study or who had worn soft contact lenses within 4 weeks before entering the study.

Success was defined as achieving an uncorrected distant Snellen VA (UCVA) improvement of or 2 lines better than 20/40 at the final evaluation. Secondary endpoints included uncorrected VA (UCVA); LogMAR VA (converted from the UCVA at each of the posttreatment visits were stratified by pretreatment mean refractive spherical equivalent (MRSE) measured by trial frame); proportion of eyes attaining ≥ 20/40 UCVA at each of the posttreatment visits; refractive change in diopters measured by trial frame from baseline to each of the posttreatment visits (Stratified by pretreatment MRSE measured by trial frame); and refractive change in diopters measured by autorefractometer from baseline to each of the post-

Table 1 Study plan 1/2

Study Plan (1 of 2)

Procedures to be done	Screening Visit	Dispensing Visit	Evaluation Visit*		Final evaluation Visit**	Follow-up Visit	Unsch. Visit
Visit No.	**1**	**2**	**3**	**4,5,6,7,8**	**9**	**10,11,12**	**–**
Day	-30	0	1+2	7±3, 14±3, 28±7, 84±14, 168±21	252±28	1, 7, 28 days after final evaluation visit	–
Informed consent signed	×						
Inclusion and exclusion criteria	×						
Demographic data	×						
Pregnancy test for applicable subjects	×						
Medical history - General (within 1 year)	×						
Medical history - Ophthalmologic (Life time)	×						
UCVA	×	×	×	×	×	×	
Best spectacle corrected VA (BSCVA)	×	×	×	×	×	×	
Compliance evaluiation				×	×		
Manifest refraction (Detemine refractive error (=Manifest refractive spherical equivalence))	×	×	×	×	×	×	
Comeal curvature (By corneal topographer)	×	×	×	×	×	×	
Ophthalmoscopy	×				×		
Intraocular pressure (By non-contact-tonometry)	×				×		
Lens order sheet (Specifications for lens after assessing optimum fit)	×						
Dispense investigational product		×					
Contact lens fitting evaluation		×					

*Except visit 3 (Day 1 visit) should be performed in the morning, all the other evaluation visits should be performed in the afternoon. Subject must wear the investigational lens at least 3 consecutive nights prior to each evaluatioin visit of visits 4 to 8.

**The final evaluation visit should be performed in the afternoon. Subject must wear the investigatioinal lens at least 3 consecutive nights prior to the final evaluation visit.

***Teast results within 1 year before screening visit are acceptable.

#The subject will be dismissed from the study after last follow-up visit.

treatment visits (stratified by MRSE measured by autorefractometer); and the changes in corneal curvature form baseline to each posttreatment visit.

Adverse event incidences other than those stated by a subject included corneal ulcer, deep neovascularization ≥ 1.5 mm (Grade 3 or worse), stromal edema (Grade 3 or worse), and reduction in best-corrected Snellen VA by ≥ 1 line for longer than 7 days.

The study plans are summarized in Tables 1 and 2, the testing protocol began immediately after lens removal. Visual acuity was measured with the Snellen acuity chart placed 6 m from the patient. The total number of correct responses was recorded and converted to Log MAR VA. Subjective refraction was performed after lens removal. Autorefraction and autokeratometry were performed at each examination using the Nikon Autorefractor/Autokeratometer, Tokyo, Japan.

Corneal topography was measured at each visit. The instrument used for this examination was the Orbscan II corneal topographer (Orbtek, Salt Lake City, UT). Corneal thickness values were averaged centrally and peripherally over a circular area 2 mm in diameter by the Orbscan

Table 2 Study plan 2/2

Study Plan (2 of 2)

Procedures to be done	Screening Visit	Dispensing Visit	Evaluation Visit*		Final evaluation Visit**	Follow-up Visit	Unsch. Visit
Visit No.	**1**	**2**	**3**	**4,5,6,7,8**	**9**	**10,11,12**	**–**
Day	-30	0	1+2	7±3, 14±3, 28±7, 84±14, 168±21	252±28	1, 7, 28 days after final evaluation visit	–
Lens fit assessment (normal, shifted upward, shifted downward, move temporally, move nasally)		×					
Lens movement assessment (below 0.5mm, 0.5~1.0 mm, 1.0~1.5 mm, 1.5~2.0 mm, Above 2.0 mm)		×					
Condition of lens edge (Normal, pressed tightly (Comea), curling)		×					
Remove lens at least 1 hour before clinical visit			×	×	×		
Physical examinatins	×						
Schimer test	×						
Pupil size assessment (photopic & scotopic)	×						
Endothelial cell count***	×						
Slit lamp biomicroscopic exam a. Edema b. Corneal vascularization c. Corneal staining d. Conjuntival hyperemia e. Palpebral conjunctival obsservations f. Other complications g. Dry eye classification	×	×	×	×	×	×	
Record reason of this additional visit							×
Concomitant medication/procedure	×	×	×	×	×	×	×
Record adverse events (AE), including glare sympton		×	×	×	×	×	×
Complete exit forom						×#	
Dismiss subjet						×#	

*Except visit 3 (Day 1 visit) should be performed in the morning, all the other evaluation visits should be performed in the afternoon. Subject must wear the investigational lens at least 3 consecutive nights prior to each evaluatioin visit of visits 4 to 8.

**The final evaluation visit should be performed in the afternoon. Subject must wear the investigatioinal lens at least 3 consecutive nights prior to the final evaluation visit.

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#The subject will be dismissed from the study after last follow-up visit.

instrument. The peripheral thickness values were located 3 mm from the center in the superior, inferior, nasal, and temporal quadrants, which were used as default settings by the Orbscan instrument.

Finally, slit-lamp biomicroscopy was performed on the morning of the third visit and in the afternoon of the following visits. The conjunctiva and cornea were evaluated for the presence or absence of injection, edema, neovascularization, and peripheral staining with fluorescein. The location and pattern of staining of the epithelium with fluorescein was recorded.

Lens Design and Fitting Philosophy

The contact lenses were designed and manufactured by DreamLens IncTaipei, Taiwan., with Boston Equalens II (oprifocon A) lens material. The diameter of the lenses was 10.6 mm. The contact lens base-curve radius (BCR) was selected using a proprietary algorithm similar to the following: BCR (mm) = apical radius+eccentricity+0.10 mm.

After a baseline examination, the overall fluorescein pattern resembled a bull's eye with 3 to 4 mm of central touch. At the secondary curve junction, the lens and cornea formed a tear reservoir that exhibited a band of mid-peripheral fluorescein pooling that sometimes may produce a circular iron ring[11]. Subjects were asked to wear their contact lenses every night consecutively and to record insertion and removal times. It was suggested that subjects obtain at least 7 hrs of closed eye lens wear per night.

Data Analysis

Data were analyzed for 1 randomly selected eye from each subject. All raw data were entered into a Microsoft Excel spreadsheet and then imported into Statistical Analysis Software for Windows. (Microsoft Corp., Redmond, WA). The statistical methodology of secondary analyses was descriptive statistics. Continuous variables including the mean, standard deviation, maximum, minimum, median, interquartile range, and 95% 2-sided confidence interval were calculated with a pairwise *t* test.

RESULTS

Sixty-four of the 82 subjects, with 128 eyes, completed the 36-week treatment period and the 4-week follow-up period of the study. In examining each of the outcome variables using the pairwise *t* test, we found that each variable changed significantly over the 36-week period.

Visual Acuity

Table 3 shows the number of subjects who achieved ≥ 20/40 UCVA mean (±SD) at each visit. The most significant improvement in VA occurred after the first night of contact lens wear ($P < 0.001$), and 128 (100%) subjects had an uncorrected VA better than 20/40 at week 36. The LogMAR VA changed from +0.92±0.91 at baseline to -0.01±0.09 at week 36. The evolution of the LogMAR VA (mean±SD) is shown in Figure 1.

Table 3 Number of subjects achieving ≥ 20/40 uncorrected Snellen visual acuity (UCVA)

Achieving ≥20/40 UCVA	Subjects
Day 1	
N	128
Success	63 (49.2%)
Failure	65 (50.8%)
Week 1	
N	128
Success	61 (47.7%)
Failure	67 (52.3%)
Week 2	
N	128
Success	114 (89.1%)
Failure	14 (10.9%)
Week 4	
N	128
Success	123 (96.1%)
Failure	5 (3.9%)
Week 12	
N	128
Success	125 (97.7%)
Failure	3 (2.3%)
Achieving ≥20/40 UCVA	Subjects
Week 24	
N	128
Success	125 (97.7%)
Failure	3 (2.3%)
Week 36	
N	128
Success	128 (100%)
Failure	0 (0.0%)
Week 36 + Day 1	
N	128
Success	68 (53.1%)
Failure	60 (46.9%)
Week 36 + Day 7	
N	128
Success	28 (21.9%)
Failure	100 (78.1%)
Week 36 + Day 28	
N	128
Success	17 (13.3%)
Failure	111 (86.7%)

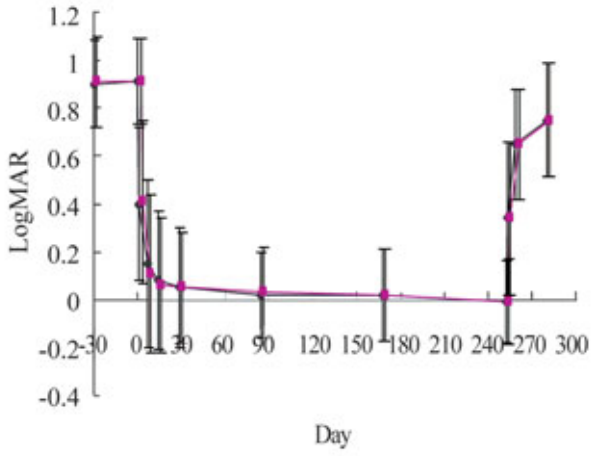

Fig. 1 Evolution of LogMAR visual acuity (mean±SD). The LogMAR VA changed from +0.92±0.91 at baseline to -0.01±0.09 at week 36. Changes were more prominent in the first week after treatment, particularly on day 1, and reached a maximal effect in week 1

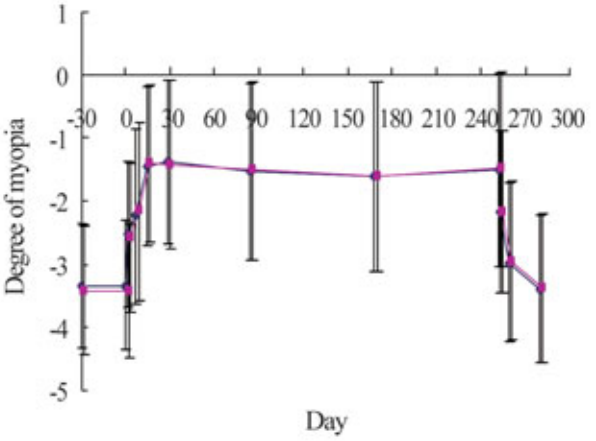

Fig. 2 Evolution of degree of myopia (D) measured by manifest refraction (mean±SD). Changes were more prominent in the first week after treatment, and recovered after discontinued the treatment at week 36.

Refractive Error

Figure 2 shows the evolution of the degree of myopia (D) measured by manifest refraction data (mean±SD) for the subjects at each visit. Significant reductions in myopia occurred over the course of the study ($P < 0.001$). The mean baseline autorefraction of -2.99±0.93 D changed significantly over the course of the study to -0.16±0.48 D at week 36. Most of the myopia reduction occurred between nights 1 and 7 of lens wear.

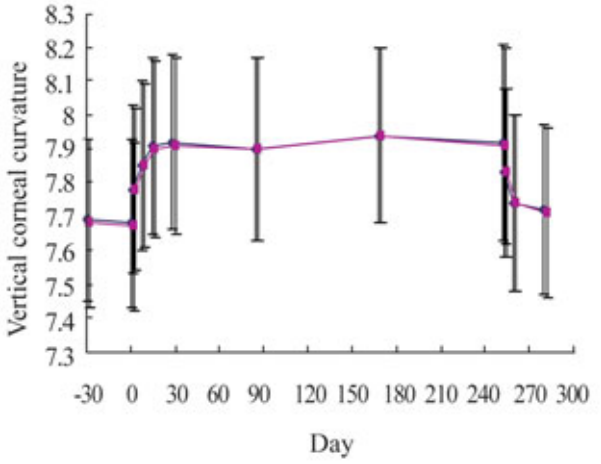

Fig. 3 Evolution of vertical corneal curvature (mm) (mean ±SD).

Corneal Curvature and Thickness

Figure 3 and Figure 4 show the mean (±SD) of vertical and horizontal corneal curvature data for subjects at each visit. Improvement beyond baseline was noted at all visits ($P < 0.001$) with a mean overall change at week 36 of +0.25±0.17 mm in the vertical position and +0.29±0.19 mm in the horizontal position. Most corneal flattening measured by autokeratometry occurred between days 1 and 7 of lens wear ($P < 0.001$).

The mean central corneal thickness at baseline was 574±25 μm. At week 36, the mean central corneal thickness, 562±30 μm, was significantly thinner than the baseline (mean change, -12±31 μm). Most of the changes in the central corneal thickness occurred between nights 1 and 7 of lens wear ($P < 0.001$).

Sustaining Ability and Safety

The data shows that all visual and refractive changes were well sustained over the course of the workday. No edema or neovascularization was observed during the study. Superficial punctate corneal staining was noted in 4 subjects over the course of the 36 weeks of lens wear. The location of this sporadic corneal staining was almost always central. However, for most subjects the amount of staining was slight and within clinically acceptable levels, and did not require discontinuation or interruption of contact lens wear. Glare symptoms at night were noted in 7 (8.5%) of the 82 subjects and 3 (3.7%) subjects experienced persistent inflammation of the eyelid. In 14 eyes (8.5%), the best spectacle-corrected VA (BSCVA)

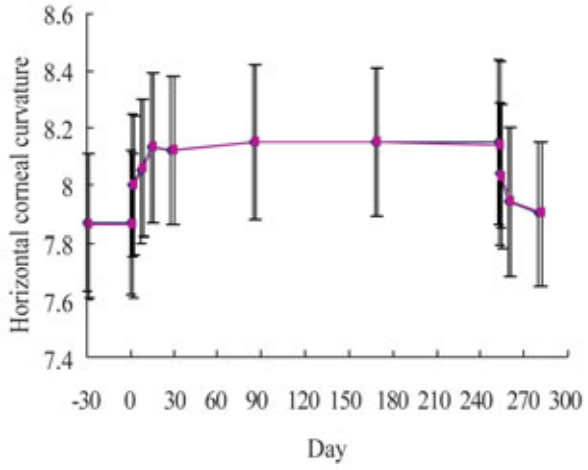

Fig. 4 Evolution of horizontal corneal curvature (mm) (mean±SD).

was temporarily reduced by 1 line for more than 7 days and recovered before the final evaluation visit. This was because of temporary decentration of the contact lens.

DISCUSSION

Hiline overnight orthokeratology using rigid gas-permeable contact lenses is effective in temporarily reducing myopia, providing good vision over the course of the day for subjects with low myopia. The corneal changes that accompanied orthokeratology were the same as those reported in previous studies. This can probably be attributed to new generation reverse geometry orthokeratology lens designs and overnight wear of the lenses. Most of the changes in visual and refractive outcome variables occurred within the first 7 nights of contact lens wear. Visual and refractive improvements continued beyond 7 nights of lens wear and leveled off around 36 weeks. Autorefraction seems to overestimate the change in refractive error, including myopia and astigmatism, produced by orthokeratology. This disparity is caused by the entrance pupil of the autorefractor being relatively large or weighted toward the peripheral cornea where less corneal change occurs. There is also a significant change in corneal topography at the edge of the flattened zone, which may contribute to this refractive effect. We believe that refractive assessment of orthokeratology in patients is best accomplished by subjective manifest refraction.

The corneal topography and thickness data provide evidence for the mechanism underlying the refractive changes that occur during overnight orthokeratology[12,13]. Corneal topography shows a flattening of the apical radius with a restructuring towards an oblate-like ellipse as noted by reductions in the corneal shape factor[14,15,16]. Recent work by Swarbrick *et al.*[17] has provided some insights into the anatomical changes occurring during orthokeratology. These researchers found a significant central thinning of the corneal epithelium and a thickening of the mid-periphery of the corneal epithelium. We have confirmed that a central thinning of the cornea occurs during orthokeratology. We believe that the refractive changes that accompany orthokeratology are caused by a redistribution of the epithelium from the central to the mid-peripheral cornea, thereby flattening the central cornea. We also believe that baseline refractive error and patient motivation are keys to success in orthokeratology.

CONCLUSION

Hiline overnight orthokeratology contact lenses produce temporary reductions in myopia. Safety evaluations show that no subjects experienced corneal ulcer, corneal scarring, corneal opacification, gross distortion in keratometer reading, or epiphora ≥1.5 hrs after lens insertion for the first 2 nights of lens wear. There were also no significant or unusual discharges from the eyes, deep neovascularization ≥1.5 mm, persistent stromal edema, or significant central corneal staining observed throughout the study. Seven (8.5%) subjects complained about glare symptoms and 3 (3.7%) subjects experienced persistent inflammation of the lid. Fourteen (8.5%) eyes had BSCVA temporarily reduced by 1 line for more than 7 days because of contact lens decentration; however, the BSCVA was recovered before the final evaluation visit. All subjects had normal ophthalmoscopy results. The average intraocular pressure decrease was 1.38 mm Hg at the final evaluation compared with the baseline intraocular pressure for all subjects. These reductions may be because of central corneal thinning. Epithelial redistribution including central corneal thinning seems to be the mechanism underlying these visual and refractive changes. Use of the novel Hiline overnight orthokeratology contact lens is an effective and safe method for the temporary reduction of myopia.

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REFERENCES

1. Carney LG. The basis for corneal shape change during contact lens wear. Am J Optom Phys Opt 1975;52:445-454.
2. Dave T, Ruston D. Current trends in modern orthokeratology. Ophthalmic Physiol Opt 1998;18:224-233.
3. Kern RL. Research in orthokeratology. Part II: Experimental design protocol and method. J Am Optom Assoc 1976;47:1275-1285.
4. Kerns RL. Research in orthokeratology. Part I: Introduction and background. J Am Optom Assoc 1976;47:1047-1051.
5. Kern RL. Research in orthokeratology. Part III: Results and observations. J Am Optom Assoc 1976;47:1505-1515.
6. Polse KA, Brand RJ, Vastine DW, Schwalbe JS. Corneal change accompanying orthokeratology. Plastic or elastic? Results of a randomized controlled clinical trial. Arch Ophthalmol 1983;101:1873-1878.
7. Binder PS, May CH, Grant SC. An evaluation of orthokeratology. Ophthalmology 1980;87:729-744.
8. Brand RJ, Polse KA, Schwalbe JS. The Berkeley Orthokeratology Study, Part I: General conduct of the study. Am J Optom Phys Opt 1983;60:175-186.
9. Holden BA, Mertz GW, McNally JJ: Corneal swelling response to contact lenses worn under extended wear conditions. Invest Ophthalmol Vis Sci 1983;24:218
10. Carkeet NL, Mountford JA, Carney LG. Predicting success with retrospective analysis of ocular characteristics. Optom Vis Sci 1995;72:892-898.
11. Liang JB, Chou PI, Wu R, Lee YM. Corneal iron ring associated with orthokeratology. J Cataract Refract Surg 2003;29:624–626
12. Freeman RA. Predicting stable change in orthokeratology. Contact Lens Forum 1978;3:21-31.
13. Kerns RL. Research in orthokeratology. Part VIII: Results, conclusions and discussion of techniques. J Am Optom Assoc 1978;49:308-314.
14. Heng LS, Khoo CY. Can contact lenses control the progression of myopia? Singapore Med J 1994;35:367 –370.
15. Pratt-Johnson JA, Warner DM. Contact lenses and corneal curvature changes. Am J Ophthalmol 1965;60:852-855.
16. Grant SC, May CH. Orthokeratology: control of refractive errors through contact lenses. J Am Optom Assoc 1971;42:1277-1283.
17. Polse KA, Brand RJ, Keener RJ, Schwalbe JS, Vastine DW. The Berkeley Orthokeratology Study, Part II: Safety. Am J Optom Phys Opt 1983;60:321-328.