REVIEW OF OPTOMETRY

Ortho-K: An Answer for Myopia Control

Myopia is a costly, life-long problem. But, orthokeratology can help control myopia and prevent further progression.

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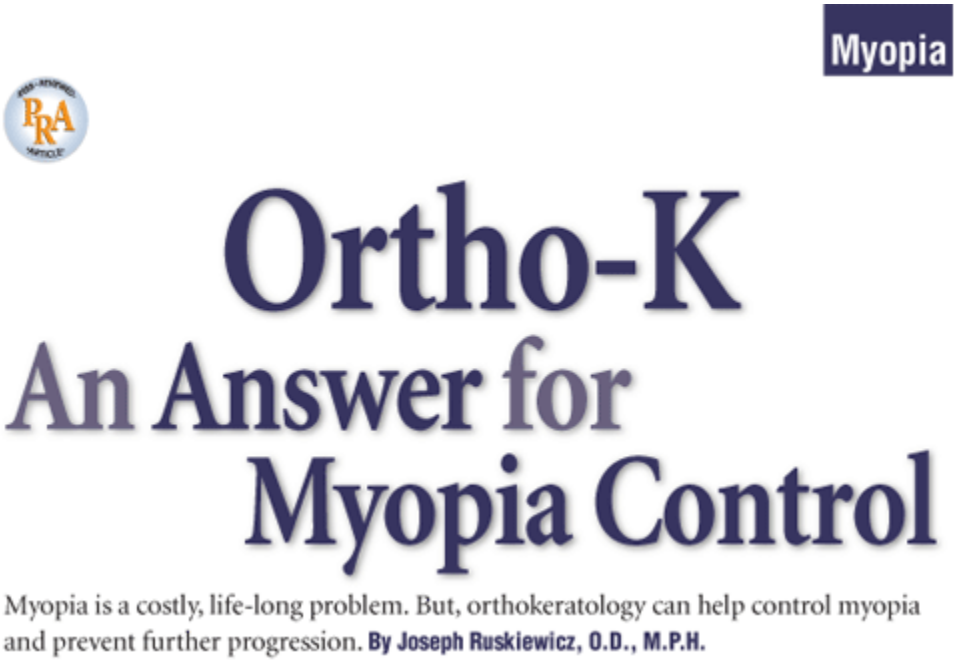

I will never forget the mother who used to get upset every time her son or daughter had an increase in myopic prescription. She always became tense during the refractive part of the examination. As I finished the refraction, she always wanted to know the findings. And, to her dismay, her son or daughters prescription usually increased. After a moment of silent anguish, accompanied with facial expressions of pain, she asked, Is there anything you can do to stop the progression?

The answer, until very recently, was no.

For countless years, progressive myopia has been a source of frustration for both optometrists and parents. The yearly ritual of finding an increase in the minus prescription for our school-aged patients is not enjoyable. As their uncorrected distance vision decreases, their ability to function without correction diminishes.

The treatment of myopia poses a very real cost to society. This cost not only includes glasses, contacts and LASIK, but also lost potential career opportunities. Many clinicians have seen young patients relinquish career options, such as becoming a state trooper, because of poor uncorrected visual acuity.

But, with the recent advent of improved orthokeratology techniques, we may now have a mechanism to control myopia progression in our young patients. This article chiefly discusses how orthokeratology can be

sed to control myopia progression, and includes two case reports that document successful inhibition of myopia progression with orthokeratology lenses.

Prevalence of Myopia

Progressive myopia is one of the most common vision problems in adults and children. In the United States, 25 % of adults are myopic.[1] In Japan, 66% of 17-year-olds are myopic.[2] Even more staggering, approximately 75% of adults who live in urban, industrialized Asian countries are myopic.[3-7]

Limited Success in Myopia Control

In the past, several techniques have demonstrated limited success in myopia control. Bifocals and reading glasses have yielded minimal success.[8-10]

Chronic use of atropine has been successful in stopping the progression of myopia; however, this treatment is not well accepted because of significant systemic, visual and ocular side effects.

In contrast to previous research, the Contact Lens and Myopia Progression (CLAMP) study showed that rigid contact lenses are not effective in slowing the progression of myopia beyond the first year.[11] Additionally, rigid contacts are not well tolerated by young patients. Discomfort, lost lenses and painful debris under the lenses typically make this treatment modality unpopular with young myopes.
A list of myopia control techniques and their respective effectiveness is summarized below (*see Myopia Control Options, below*).

Myopia Control Options				
Treatment	Patient Acceptance	Ease of Compliance	Degree of Myopia Control	Cost
Atropine	Poor	Moderate, stinging reported	High[12]	Low
Pirenzepine[13,14]	Reportedly good	B.i.d. dosing	Moderate	Unknown
Undercorrected spectacles	Poor	Good	Poor; may increase myopia[15,16]	Standard Cost
Bifocal lenses	Good	Moderate	Poor[11,17]	Moderate
Reading Rx	Good	Poor	Poor[17]	Moderate
Progressive addition lenses	Good	Moderate	Poor[8,9]	High
Increased illumination when reading	Good	Moderate	Unknown	Minimal
Avoid short reading distance*	Good	Moderate	Unknown; may play no role[18,19]	None
Night lights	Good	Good	None[20-22]	Minimal
Standard soft contact lenses	Good	Good	Poor[23]	Moderate
Rigid gas-permeable contact lenses	Moderate to poor for young patients	Good	Poor; moderate for some during the first year[11]	Moderate
Orthokeratology	Good	Good	High[27-29,31]	High
Soft bifocal contact lenses	Good	Good	Promising[30,32]	Moderate
*Less than Harmon distance, as measured from the first knuckle to the elbow of the reader.				

Orthokeratology

Orthokeratology may offer the most effective technique for myopia control, and it is well tolerated by children. Typically, comfort is not a problem; the lenses are much more comfortable with closed lids, as compared to the constant blinking associated with daytime gas-permeable lenses.

Both patients in the following cases presented with progressive myopia. During the time that they wore orthokeratology lenses, neither patient demonstrated myopia progression.

Female Patients Refractive History		
Exam Date	Refractive Findings	Age (Born: 8/31/88)
October 23, 1990 to July 21, 1994	Four eye exams with low plus found	2 to 5
July 9, 1995	-1.25D sph O.D. **-1.25D sph O.S.**	6
February 3, 1996	-1.75D sph O.D. -2.00D sph O.S.	7
January 4, 1997	-2.00D sph O.D. -2.25D sph O.S.	8
August 7, 1998	-2.00D sph O.D. -2.50D sph O.S.	9
February 15, 1999	-2.00D sph O.D. -2.50D sph O.S.	10
August 7, 2000	-2.25D sph O.D. Add of -3.00D sph O.D. +0.75D	11
June 15, 2001	-2.50D sph O.D. -3.00D sph O.S.	12
June 29, 2001 to August 29 2007	Fit with orthokeratology lenses. Yearly eye exams found between -0.25D to +0.75D	12 to 18
July 14, 2008	Discontinued orthokeratology lenses	19
July 28, 2008	-2.25D sph O.D. -2.75D sph O.S.	19
August 25, 2008	-2.25D sph O.D. -2.75D sph O.S.	20

Case 1: 20-Year-Old Female

This patient has two myopic parentsone is a -5.50D myope and the other is a -7.00D myope. *(See Female Patients Refractive History, left.)*

Most clinicians would diagnose her with early-onset progressive myopia. Because of her risk for myopia, she previously used reading glasses. Bifocals were also incorporated into her minus correction when she did develop myopia.

At her June 15, 2001 visit, refractive error measured -2.25D sph O.D. and -3.00D sph O.S. Initial keratometry readings were 44.37D x 173, 45.00D x 083, average E of 0.67mm O.D. and 44.25D x 002, 45.00D x 092, average E of 0.44mm O.S., as measured by Topcon KR7000P. Slit lamp examination revealed healthy corneas and conjunctiva. All other findings were normal, except 4 prism diopters of exophoria at near.

On June 29, we fit her with overnight orthokeratology lenses; she was nearly 12 years old. We used the

Emerald Lens (Euclid Systems Corporation, Bausch & Lomb). The Emerald is a reverse-geometry lens that uses four zonesthe first alignment curve is typically equal to the subjects flat K, the central base curve is flatter than the flat K in an amount equal to the amount of myopia being targeted for correctionplus an additional 0.75D flatter to compensate for any rebound upon lens removal. The overall diameter (OAD) is determined by horizontal visible iris diameter (HVID); 10.6mm is most commonly used. The reverse curve data is calculated from a proprietary algorithm, which can be adjusted to change the saggital depth, if required. Lenses are designed empirically from K readings, refraction and HVID, with a first fit success rate ranging between 75% and 80%.

We fit this patient with these parameters:
O.D.: 8.23mm (BC) +0.75D, 11.0mm, 0.6mm/***, 0.8mm/ 7.73mm, 0.6mm/7.91mm, 0.4mm/ 11.50mm.
O.S.: 8.36mm (BC) +0.75D, 11.0mm, 0.6mm/***, 0.8mm/ 7.75mm, 0.6mm/7.93mm, 0.4mm/ 11.50mm.
(*** Radius of the reverse curve.)

In August 2008, we reduced the amount of targeted myopia by 0.50D. However, no additional changes were made to the parameters during seven years of lens wear.

After the successful fit, we monitored the patient every six months. Her corneas remained healthy and the refractive error was stable. After seven years of wearing overnight orthokeratology lenses, she developed a sensitivity to her contact lens solution and elected to switch to spectacles. Her spectacle refraction has remained stable for the past six months.

Male Patients Refractive History

Exam Date	Refractive Findings	Age (Born: 4/17/85)
February 19, 1992 to April 9, 1994	Low plus to plano	6 to 9
April 22, 1995	-0.50D sph O.D. -0.50D sph O.S.	10
August 7, 1996	-0.50D sph O.D. -0.50D sph O.S.	11
November 29, 1997	-1.00D sph O.D. -1.00D sph O.S.	12
November 27, 1998	-1.25D sph O.D. -1.25D sph O.S.	13
January 6, 2001	-1.50D sph O.D. -1.50D sph O.S.	15
February 12, 2002	-1.75D sph O.D. -1.75D sph O.S.	16
February 22, 2003	-2.00D sph O.D. -2.00D sph O.S.	17
February 26, 2003 to August 18, 2008	Fit with orthokeratology lenses, yearly refractions found plano to -0.50D	17 to 23
September 17, 2008	-1.25D-0.25D x 075 O.D. **-1.25D sph O.S.**	23

Case 2: 23-Year-Old Male

This patient has one parent who is a -5.00D myope. The second parent demonstrates +5.25D-1.00D x 015 in an amblyopic eye and -1.50D of myopia in the fellow eye. *(See Male Patients Refractive History, left.)*

At his February 22, 2003 visit, refractive error measured -2.00D sph O.U. Initial keratometry readings were 41.12D x 015, 41.73D x 105 O.D. and 40.75D x 150, 41.75D x 160 O.S. with the Topcon KR7000P.

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Slit lamp examination revealed healthy corneas and conjunctiva. All other findings were normal, except for 6 prism diopters of esophoria at near.

On February 26, we fit him with overnight orthokeratology lenses; he was 17 years old. We used the Emerald lens, which required one change during the fitting. Following the change, he was fit with a 11.0mm diameter lens due to a large, flat, spherical cornea.

We fit this patient with these parameters:
O.D.: 8.71mm (BC) +0.75D, 11.0mm, 0.6mm/***, 0.8mm/ 8.30mm, 0.6mm/8.35mm, 0.4mm/ 11.50mm.
O.S.: 8.71mm (BC) +0.75D, 11.0mm, 0.6mm/***, 0.7mm/ 8.29mm, 0.7mm/8.35mm, 0.4mm/ 11.50mm.

After the successful fit, the patient was monitored at six-month intervals. The parameters remained the same throughout the course of lens wear. His corneas remained healthy and stable. After five years of wear, he elected to switch to spectacles. He made the switch because he was recently married and had moved a considerable distance from the office.

Emmetropization Gone Wrong

In optometry school, you likely learned about emmetropization. This process helps guide the developing eye to balance the refractive components with the axial length. Myopia represents a breakdown in this process, which results in varying degrees of reduced distance vision.

Until recently, the exact cause of childhood myopia has eluded researchers and clinicians. There is growing evidence, however, that hyperopic peripheral retinal defocus may be the cause. In this case, myopia develops because the peripheral retina receives light rays that are focused behind the retina. During growth years, the axial length of the eye is increased in an attempt to bring the hyperopic focus onto the peripheral retina. Animal experiments further support this theory of myopia development.[24,25]

A recent study found that orthokeratology lenses were able to reduce the peripheral hyperopic retinal focus.[26] This, in turn, would stop the signal to the eye that caused myopic growth, which might explain why orthokeratology is successful in arresting myopia.

Control Myopia with Ortho-K

While these case reports demonstrate promising results, we must remember that, at one time, most practitioners believed GP lenses absolutely stopped the progression of myopia.

Are there studies that show orthokeratology lenses as the most effective technique in halting the persistent advancement of myopia? Though our two cases demonstrated no advancement in myopia while wearing orthokeratology lenses, more conclusive evidence is needed. Fortunately, several studies document similar success rates.

One of the earliest studies was performed by orthokeratology pioneer Thomas Reim, O.D. Though not a

andomized clinical study involving controls, the results did show only minimal myopia increase in a group of 462 young patients. The average yearly increase was -0.13D during a three-year-period.[27]

The Longitudinal Orthokeratology Research in Children (LORIC) study in Hong Kong measured refractive error, axial length and vitreous chamber depth.[28] After 24 months, when compared with spectacle wearers, patients who wore orthokeratology lenses demonstrated significantly less increase in all measurements.

And very recently, participants in both the Corneal Reshaping and Yearly Observation of Nearsightedness (CRAYON) study and the Stabilization of Myopia by Accelerated Reshaping Technique (SMART) study demonstrated comparable visual outcomes to subjects in the LORIC study.[29,31]

Orthokeratology lenses appear to be an effective clinical technique to control the progression of myopia. However, until large-scale clinical trials have been conducted, we cannot forthrightly make this claim. Though orthokeratology lenses are FDA-approved, employing them for myopia control is an off-label use.

Nevertheless, we can inform our patients that several studies indicate orthokeratology is an effective technique for controlling myopic progression. We should offer orthokeratology to every progressive myope who is within the successful fitting parameters.

Orthokeratology lenses are well tolerated because they provide good comfort behind closed eyes. Additionally, children do not have to wear the lenses during the day, which allows them to participate in sports, such as swimming, without worrying about glasses or contact lenses. I recommend that you begin fitting your young myopic patients, and keep their prescription low and stable. They will become appreciative and loyal patients.

Make a Miracle in the Morning

On the night that I dispense orthokeratology lenses, I use a very rewarding technique that I adopted from Gary Gerber, O.D., to help build enthusiasm with the patients whole family.

I ask the patient to read the acuity chart, with uncorrected vision, before dispensing the lenses. Then, beginning at the 20/20 line, I increase the size of the letters until the patient reaches his or her expected, generally very poor, uncorrected visual acuity.

When this unaided binocular visual acuity is finally obtained, the family can readily see and understand the degree of disability that is caused by myopia.
After evaluating the fit the next morning, I remove the lenses. I measure acuity in the opposite direction, starting with the previous line of uncorrected visual acuity.
As the child reads progressively smaller Snellen lines, the parents are usually so impressed with the improvement that I hear comments such as, Thats a miracle, Thats unbelievable, or, as one father (an accountant) said, This is better than getting a clean report on an IRS audit!

Hearing praise like that is a great way to start a morning, and it gives the parents extra enthusiasm to help encourage their child if he or she begins to lose interest in the process.

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