Current Research in Corneal Reshaping

An in-depth review of some of the latest research presented at the Global Orthokeratology Symposium.

By Craig W. Norman, FCLSA

The recent 2005 Global Orthokeratology Symposium in Chicago was once again a success. A well-known faculty presented numerous presentations on corneal reshaping topics combined with an international Free Paper section and 30 scientific posters on this subject.

While eyecare practitioners are becoming more adept at fitting and managing ortho-k patients, we still have much to learn as this field is evolving. The high attendance at the all-day Fundamentals of Orthokeratology was a testament to practitioners' willingness to learn about this procedure.

Fundamentals Program

Eef van der Worp, BSc Optom, reported on patient selection in ortho-k with emphasis on choosing only patients whose spectacle prescriptions and corneal topography are well-suited for this procedure. "While there are FDA approvals for up to –6.00D of myopia, patients will generally have the most predictable results up to –4.50D," stated Dr. van der Worp. "It's also important to note not only the amount, but the location of any astigmatism. Today's designs can correct only corneal astigmatism, primarily with-the-rule (WTR) astigmatism where the axis is within 30 degrees of the horizontal meridian. Even then, only a 50 percent reduction in the amount of astigmatism can occur, therefore choose only patients who have a maximum of –1.50D of WTR astigmatism," he said. Also, it's helpful to note if the corneal astigmatism is apical only or extends from limbus to limbus (Figure 1). "Patients who have limbus-to-limbus astigmatism are difficult to fit due to lens rocking and the tendency for the lens to position high on the cornea," said Dr. van der Worp.

Randy Kojima from Vancouver, BC, presented Pre-fitting Corneal Topography for Corneal Reshaping, pointing out that a real key to successful ortho-k fitting is the acquisition of accurate corneal maps at pre-fitting and during progress checks.

"The initial information capture is the most critical," said Kojima. "Multiple image captures are much more useful than taking just one single corneal measurement." He continued, "Then, to ensure accuracy, I review

Craig Norman is director of the Contact Lens Section at the South Bend Clinic in South Bend, Indiana. He is a fellow of the Contact Lens Society of America and is an advisor to the GP Lens Institute.

the maps simultaneously to look for symmetry between captures along with any obvious error. If I'm concerned about the quality and reproducibility of the images, I take additional maps as necessary."

Kojima also explained how to use different maps. "The axial map is best for defining astigmatism and

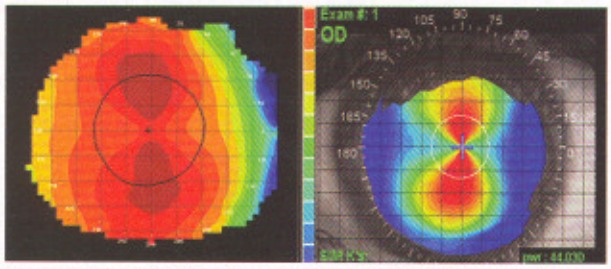


Figure 1. Extent of astigmatism affects ortho-k success.

determining the apical radius. Conversely, a tangential (instantaneous/true) map is best for determining curvature at a specific point," he said (Figure 2).

The real key, though, is the use of difference (or subtractive) maps, which plot the difference between two captures — such as a baseline (pre-fit) measurement and a post-fit visit. This demonstrates specific changes in radius and prescription during the fitting process. Subtractive Maps are also quite useful for evaluating the position and size of the treatment zone, the lens position (because the lens usually isn't worn into the office) and any surface aberrations that have occurred secondary to overnight ortho-k wear.

Research from the General Sessions

Myopia A real highlight of the symposium was a discussion of myopia and a review of investigations and studies on contact lens-induced myopia control.

Brien A. Holden, B App Sc, PhD, from Sydney, Australia led off this discussion with a review of myopia across the world. "Myopia affects 1.6 billion people globally and is a serious public health issue," stated Dr. Holden, quoting studies demonstrating that higher myopic patients (above –6.00D) have an increased risk of retinal detachment, cataracts and glaucoma. "Uncorrected myopia decreases quality of life, increases economic cost and reduces learning opportunities for children," he said.

"While myopia is viewed as simply a correctable error in the Unites States, there are countries in Southeast Asia such as Taiwan and Hong Kong where up to 80 percent of the overall population is myopic," said Dr. Holden. "In fact, the World Health Organization has identified uncorrected refractive errors as one of the five priority areas for The Global Initiative to Eliminate Avoidable Blindness by the Year 2020."

Earl L. Smith III, OD, PhD, from the University of Houston, in his presentation on the Mechanisms of Myopia, described many of the longstanding theories regarding the etiology of myopia, based on both genetic and environmental factors. Quoting a 1977 study by Wiesel & Raviola, he discussed form deprivation myopia (FDM) where depriving the eye of form vision promotes axial elongation and myopia (chronic image degradation can cause myopia). Of importance, the ocular changes in FDM are similar to those associated with juvenile-onset myopia. Therefore, the potential for a clear retinal image is essential for normal refractive development.

Dr. Smith believes that peripheral vision can influence foveal refractive development. "Peripheral form deprivation can produce axial myopia at the fovea," he stated, "and the peripheral retina by itself can regulate emmetropization." He also discussed how a functioning fovea is not essential for emmetropizing responses.

"As a consequence of eye shape and/or aspheric optical surfaces, 'corrected' myopic eyes often experience significant hyperopic defocus across the visual field. Under-correction may not be an effective strategy for slowing myopic progression because small degrees of under-correction aren't likely to eliminate peripheral hyperopic errors," Dr. Smith stated. "By increasing the effective curvature of field it would be possible to correct central errors and either correct

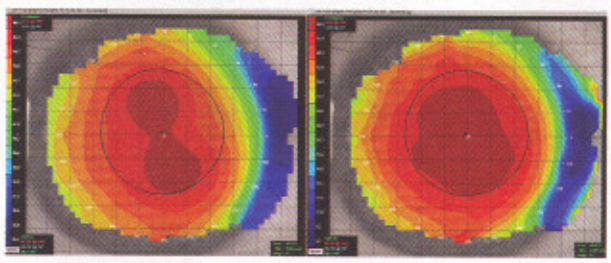


Figure 2. Axial (left) and tangential topography maps.

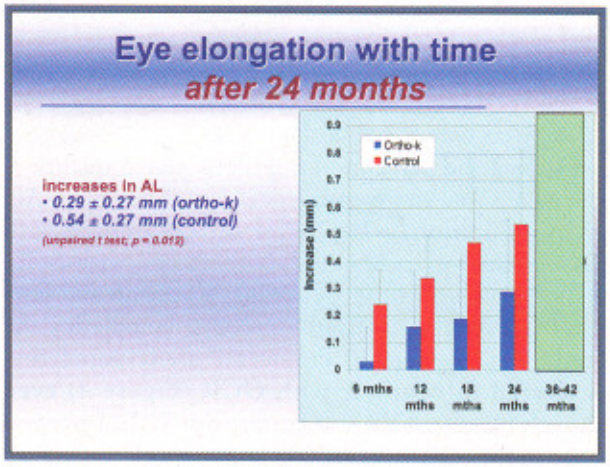
peripheral errors or induced peripheral myopic defocus." This may explain why some of the earlier efforts in studying myopia control with GP lenses demonstrated results that were less positive than anecdotal reports have suggested through the years. Such studies "focused" images clearly on the fovea rather that utilizing a "defocus" mechanism.

Myopia Control with GP Lenses Jeffrey J. Walline, OD, PhD, presented the CLAMP Study results. (You can see these results in detail by turning to Dr. Walline's article "GP Contact Lenses and Myopia Control: Where Are We Now?" on p. 52.)

One of the more interesting findings of his work was that 80 percent of the myopic children enrolled in this study initially adapted to GP wear with 70 percent of successful adapters becoming "lifetime" wearers. Dr. Walline concluded that GPs slowed myopia progression significantly, but the treatment effect is likely not permanent with this method.

Pauline Cho, BOptom, PhD, from Hong Kong Polytechnic University discussed Myopia Control With Orthokeratology. She set out to determine if ortho-k is effective for myopia reduction and control through a two-year study that monitored axial length (AL) and vitreous chamber depth (VCD) changes in children undergoing ortho-k treatment. She then compared this data to the rates of change in AL & VCD for 35 children wearing single-vision spectacles from an earlier study.

The subjects were children aged 7 to 12 years who had a spherical refractive error of –0.25D to –4.50D and astigmatism less than –2.00D. Among the many



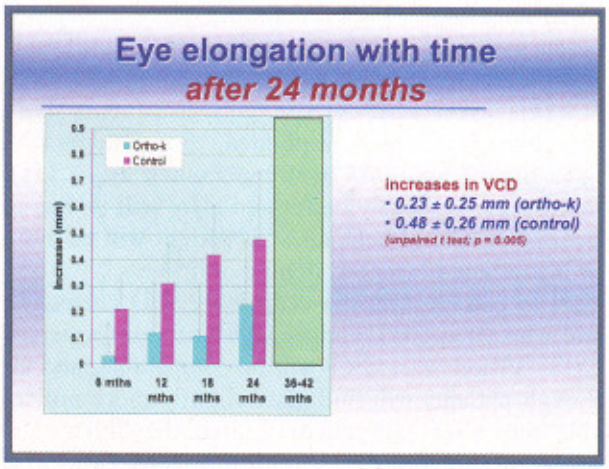


Figure 3. After 24 months of overnight ortho-k wear, children's AL and VCD increased only about half as much as that of the control group.

data collected were vision (logMAR chart), refraction, corneal topography/thickness, AL and VCD.

Of the initial 43 subjects, 35 (16 male, 19 female) completed the study. Researchers evaluated eye elongation over the 24-month monitoring period. The mean change in AL was 0.14mm (about 0.39D) for the ortho-k group and 0.27mm (about 0.75D) for the control subjects (Figure 3).

Variability in the AL and VCD changes was quite large — on average, ortho-k lens wear significantly slowed eye elongation, but some children still showed a large increase.

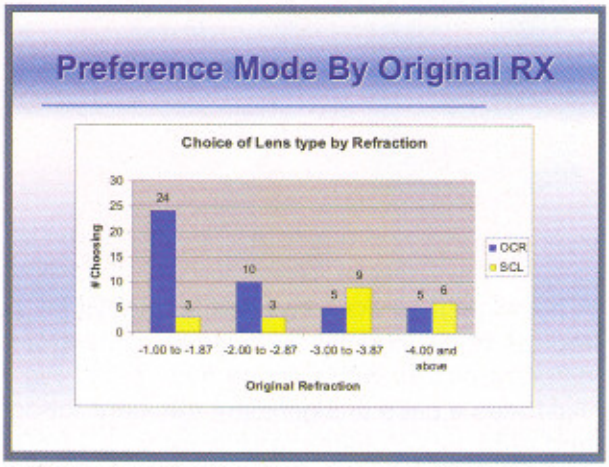


Figure 4. Most lower myopes — and some higher myopes — preferred ortho-k correction to soft lens correction.

In conclusion, ortho-k was effective for myopic reduction, and the mean eye elongation in ortho-k children was about half that of spectacle-wearing children. While this is just one study and has a small study sample, it shows that ortho-k may prove an option for slowing myopia progression in children.

Optics of Orthokeratology If orthokeratology may indeed control myopia progression, what optics of orthokeratology will facilitate this?

Jennifer Choo, OD, from Sydney, Australia presented a paper on this topic. Her interest is to determine the ideal shape of the cornea after ortho-k and to understand the optical limits to correction with varying pupil sizes and refractive errors.

Using software, an optical model of the eye was created with various pupil sizes (3.0mm to 6.5mm), a series of refractive errors (up to –8.00D), epithelium isolated as a variable in thickness and ray tracing optimized for defocus and aberrations.

"Optical modeling provides a useful tool for understanding optical changes and may be useful to help design lenses to optimize patient vision," said Dr. Choo. "There is an ideal shape of the cornea after orthokeratology. To correct vision, the shape will aim to minimize optical defocus and aberrations. In particular, to decrease myopia progression, it will likely need to incorporate aberration control."

Ortho-k vs. Soft Lens Wear Michael J. Lipson, OD, from the University of Michigan presented Overnight Corneal Reshaping vs. Soft Disposable Contact Lenses: Vision-Related Quality of Life Differences From a Randomized Clinical Trial. This study evaluated patients' visual acuity, symptoms and perceptions of vision-related quality of life in a randomized crossover clinical trial of overnight corneal reshaping (OCR) using Paragon CRT lenses and daily wear disposable soft lenses (SCL).

He evaluated the vision-related quality of life with the NEI RQL-42, which consists of 42 multiple choice questions that rate many attributes such as overall clarity, near and far vision, diurnal fluctuations, expectations and activity limitations, etc.

Researchers randomly assigned qualified subjects to wear one mode for eight weeks and complete the RQL-42 at the end of that time. After a washout period, each subject wore the alternate mode for eight weeks, completed the RQL-42 then chose which mode they preferred. Of 81 subjects who enrolled, 65 subjects completed both phases.

Among the perception of vision-related quality of life were some statistically significant differences. Activity limitations were better or less limited with OCR, while glare was less bothersome with SCL. Patients had less dependence on correction and fewer ocular symptoms with OCR. After completing the study, 67.7 percent of the overall study population preferred to continue with OCR (Figure 4) even though measured VA was better with SCL. Low myopes prefer OCR over SCL although glare is more of an issue with OCR. While measured acuity was better with SCL, subjective acuity wasn't significantly different between the two modes.

When asked what you can tell your patients about this study, Dr. Lipson responded, "For patients who have higher amounts of myopia, such as –4.25D, SCL vision is slightly better and glare will be less of a problem. Conversely, an SCL patient will be more prone to lens awareness, itching or dryness."

"For patients who have up to –2.50D correction and who tried CRT and SCL, 85 percent preferred CRT. Vision with CRT will be comparable, and although patients will find glare slightly more noticeable, they'll feel less activity-limited, they'll have less problem with dry eyes, itching or lens awareness during the day, plus they'll feel less dependent on their correction." **CLS**