Pharmacologic Approach to Presbyopic Correction Shows Promise

The small-aperture approach to increasing depth of focus is applied to the pupil.

BY STEVEN J. DELL, MD

Presbyopia is a frustrating and universal phenomenon of aging. Patients frequently tell their eye care provider that they would do almost anything to regain their near visual acuity. A variety of surgical strategies have been used to address this condition, with varying degrees of success. Although multifocal and accommodating IOLs offer options for pseudophakes, the options for phakic presbyopes are limited.

A GIVE-AND-TAKE

A recurring theme in presbyopic treatment has been the balance between improvement in near vision and the loss of visual quality at distance. Every currently available presbyopia-correcting technology degrades distance acuity to some degree. Even accommodating IOLs require some slight degree of defocus or mini monovision to produce high-grade near vision.

Photographers grapple with the same optical issues that presbyopic individuals face. At times, a photographer may use a large aperture to achieve a narrow depth of focus to emphasize a particular portion of an image. When a wide depth of focus is desirable, a small aperture is used. In fact, with a small enough aperture, extreme depth of focus can be achieved. In photography, a small aperture obviously reduces the light available to expose the film (or, more commonly, the digital sensor). Very small apertures require very long exposure times.

In the eye, the same optics apply. If a small aperture could consistently be achieved, it would result in extremely good depth of focus. Although this would inevitably reduce the amount of light reaching the retina, in this situation, the human retina vastly outperforms any digital sensor. The human retina is capable of functioning over an extraordinary range of illumination levels. Rods operate over a 100-millionfold range of illumination, and cones operate over a 100-billionfold range. Together, human rods and cones span a 1-quadrillionfold range of illumination.[1] This incredible range of function allows excellent vision even at smaller pupillary sizes.

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The Kamra inlay (AcuFocus) uses a 1.6-mm central aperture pinhole corneal inlay to achieve good near vision using the principles just outlined. The 1.6-mm size was selected to balance depth of focus with sufficient light availability for good vision. Promising clinical results have been seen internationally, and this product is currently under review for marketing clearance by the FDA.

A NOVEL APPROACH

A novel pharmacologic approach to expanding depth of focus has been under investigation by a small

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company called Presbyopia Therapies. The company has developed a proprietary topical drop known as PRX-100 that effectively creates miosis without the stimulation of accommodation. The components of PRX-100 are proprietary, but the clinical results with this product have been encouraging. The effect on pupillary size is rapid in onset, with a stable pupillary diameter of approximately 1.6 mm maintained for about 8 hours. Importantly, the pupillary diameter remains stable throughout the duration of action, and a myopic shift has not been observed.

Instead of an aperture placed at the corneal plane, which could degrade optical quality, PRX-100 relies upon the pupil itself to create an expanded depth of focus. As a result, the drop is designed for binocular use. Internal data from Presbyopia Therapies indicate that the best pupillary diameter to provide both good distance and near vision ranges from 1.6 to 1.9 mm. This comports with the strategy used by Acufocus with the Kamra's 1.6-mm aperture. Subjects treated internationally with PRX-100 have not reported browache or reduced distance visual acuity. In fact, they have demonstrated improved distance acuity, along with superb near acuity, typically in the range of J1 or J1+.

Presbyopia Therapies intends its product to be used during the day; however, many trial participants have reported improved night vision as well. It seems that, at the pupillary size achieved by the product, dramatically improved contrast sensitivity and the elimination of stray light trump the loss of light transmission to the retina.

RESULTS AND LIMITATIONS

David Castillejos, MD, in Tijuana, Mexico, conducted a pilot study of PRX-100. Nine patients whose mean age was 51.3 years achieved binocular mean distance-corrected near visual acuity of 20/22.7 at 14 inches, equivalent to J1 to J1+. If the testing had been performed at the more familiar 16 inches, even better results might have been found. Importantly, subjects reported excellent overall quality of vision and no browache. Additional studies outside the United States have yielded similarly encouraging results.

There are limitations to this product. Conjunctival injection and some stinging occur upon instillation. Some subjects reported minimal dimming of vision, but they said that this phenomenon generally lasted only for the first few days of use. Enrollment in a phase 2 US clinical trial is planned to begin soon.

Although these results are early, they are promising. The concept of using a pharmaceutical approach to the treatment of presbyopia would likely appeal to a large percentage of our patients. Indeed, it may appeal to many individuals who would never consider vision correction surgery. If this product truly produces good near acuity while preserving or improving the quality of distance vision, it will be a remarkable addition to our armamentarium for treatment of presbyopia. ■

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1. Ryan SJ, Schachat AP, Wilkinson CP, et al. *Retina*. 5th ed. Philadelphia: Elsevier; 2013.