Peer-Reviewed Literature:

Monovision Correction With Refractive Surgery

Editor: Ming Wang, MD, PhD, Clinical Associate Professor of Ophthalmology at the University of Tennessee and Director of the Wang Vision Institute in Nashville, Tennessee

Co-Editor: Tracy Swartz, OD, MS, Educational Director at the Wang Vision Institute in Nashville, Tennessee

Reviewer: Helen Boerman, OD, Assistant Clinical Operations Manager at the Wang Vision Institute in Nashville, Tennessee, and Staff Optometrist, Adjunct Faculty at Indiana University School of Optometry in Bloomington

Panel Members: Y. Ralph Chu, MD; Wei Jiang, MD; Baseer U. Khan, MD, FRCS(C); Gregory J. McCormick, MD; Jason Noble, BSc, MD; Lav Panchal, MD; Jay S. Pepose, MD, PhD; Paul Sanghera, MD; Renée Solomon, MD

Ophthalmologists commonly perform keratorefractive surgical procedures such as LASIK, PRK, and conductive keratoplasty (CK; Refractec, Inc., Irvine, CA) to address presbyopic patients' loss of reading vision. Monovision, a technique that corrects one eye for distance vision and the other for near, has been successful in contact lens wearers for decades. Many factors influence its successful application, including patients' expectations, ocular dominance, interocular blur suppression, binocular visual acuity, age, gender, and preoperative refractive error. The following articles were reviewed for the analysis of monovision's success and its application to refractive surgery:

1. *Miranda D, Krueger RR. Monovision laser in situ keratomileusis for pre-presbyopic and presbyopic patients.* J Refract Surg. *2004;20:325-328.*

2. *Goldberg DB. Comparison of myopes and hyperopes after laser in situ keratomileusis monovision.* J Refract Surg. *2003;29:1695-1701.*

3. *Goldberg DB. Laser in situ keratomileusis monovision.* J Cataract Refract Surg. *2001;27:1449-1455.*

4. *Jain S, Ou R, Azar DT. Monovision outcomes in presbyopic individuals after refractive surgery.* Ophthalmology. *2001;108:1430-1433.*

5. *Schuler E, Silverberg M, Beade P, Moadel K. Decompensated strabismus after laser in situ keratomileusis.* J Cataract Refract Surg. *1999;25:1552-1553.*

6. *Jain A, Aurora I, Azar DT. Success of monovision in presbyopes: review of literature and potential applications to refractive surgery.* Surv Ophthmol. *1996;40:491-499.*

FACTORS INFLUENCING MONOVISION'S SUCCESS

Patients' Expectations

The goal of monovision is to increase patients' functional vision for daily tasks without the aid of glasses. This endpoint, however, does not preclude a person's ability to use glasses for tasks requiring clear binocular distance vision (ie, night driving) or sharp binocular near vision (ie, prolonged reading). Although some patients are satisfied with monovision, they face disadvantages such as less-than-ideal distance vision; the possible need for glasses when driving at night; two eyes, each focusing differently; and the adjustment involved with this form of correction.[1-4]

Ocular Dominance and Interocular Blur Suppression

Interocular blur suppression is essential to successful monovision. In each person, the input from one eye or

the other is usually dominant in influencing binocular cells in the cerebral cortex. Information from an individual's dominant eye produces a greater response to a given stimulus than input from his nondominant eye. Correcting the dominant eye for distance and the nondominant eye for near is standard, because (1) correcting the dominant eye for the most commonly used viewing distance maximizes blur suppression and (2) the dominant eye maximizes the performance of visual tasks requiring spatial perception.[4] Although this approach is the norm in the studies reviewed for this article, Jain et al[4] reported that 43% of 42 study patients were treated with crossed monovision (wherein the dominant eye is corrected for near), and subjects' satisfaction ranged from 72% to 86%. Although this range was relatively high, it was the lowest rate of patient satisfaction among the studies reviewed herein.

Age and Gender

Presbyopes' age and gender can influence their acceptance of monovision. Two of the published studies compared monovision's success in younger versus older presbyopes. Miranda et al[1] studied 374 patients whose average age was 48 ±7.7 years. They found that the rate of success was higher in older patients (93.87%) than in younger ones (88.23%).

Goldberg's[3] results were similar. He found that measuring the advantage of monovision in the 40- to 45-year-old group was difficult and that older presbyopes benefited more as their accommodative amplitude decreased. Jain et al[4] studied a series of 42 monovision patients whose average age was 49.7 ±3.9 years, but the investigators did not detect differences in these patients' satisfaction that were related to their age.

Goldberg's[3] was the only study that analyzed gender. He found statistically significant differences between men and women with regard to monovision. Women chose monovision 2:1 compared to men, and this difference correlated with survey responses that indicated a preference for full distance correction due to gender-related differences in sports participation, occupation, and concern with a loss of depth perception and about having two eyes with differing focus.

Refractive Error

In another study, Goldberg[2] analyzed differences between myopes and hyperopes undergoing LASIK monovision. He found that visual results were better in myopes than in hyperopes (*P*=.043), the number of enhancements was higher with monovision (*P*=.04), and satisfaction was higher among myopes (*P*=.12) as well as patients who received full distance correction (*P*=.002). He also found that monovision hyperopes had experienced more side effects (glare, halo, difficulty in dim light and with depth perception) because of high corrections or strong sighting preferences. Goldberg noted that the advantage in correcting myopes with monovision is that, if they are dissatisfied, an enhancement to full distance correction can address the residual myopia without ablating more corneal tissue. However, when correcting hyperopia, an enhancement to full distance vision involves reversing some of the original correction in the near eye. Eyes that have undergone hyperopic LASIK are associated with variable results on topography due to irregular astigmatism and increased higher-order aberrations on wavefront aberrometry.

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Simulation With Contact Lenses

The preoperative simulation of monovision with contact lenses can be an invaluable tool for identifying patients who can adapt to such a correction and preventing postoperative dissatisfaction. The importance of a trial varied between studies. Miranda et al[1] explained monovision LASIK to all patients in their study and promised an enhancement to full distance vision if subjects were dissatisfied. However, the investigators offered contact lens trials to hyperopic patients who seemed uncertain of whether they would tolerate monovision. Jain et al[4] only utilized a simulation with contact lenses in 24% of their patients, and, of these, all requested monovision with refractive surgery. Only 19% of monovision patients in Goldberg's study[3] had tried it with contact lenses, but 89% of them reported that monovision after LASIK was superior to contact lens monovision. In addition, 23% of patients in his study who chose full distance correction declined monovision because of previous dissatisfaction with their contact lenses.

Although monovision trials were not mandatory in any study, Schuler et al[5] reported a case of decompensated nerve IV palsy with vertical diplopia after bilateral LASIK for monovision. The investigators believed diplopia occurred because of a loss of fusion due to blur induced by monovision correction. The patient received corrective spectacles to restore his binocular distance vision, but a prism was necessary to eliminate his double vision. Simulating monovision preoperatively with contact lenses is

certainly advantageous, but not all patients are willing to take this extra step. Goldberg[2] suggested making trials for hyperopes considering monovision mandatory, because a reversal to distance correction could result in complications. Regardless, careful binocular testing is necessary in all candidates to rule out certain binocular conditions that may pose a problem postoperatively.

> "Monovision presents a viable option for presbyopes considering refractive surgery."

VISUAL PERFORMANCE IN MONOVISION

Goldberg[2] found that the visual outcome must be excellent for monovision to be considered a success. Patients require 20/30 or better uncorrected distance vision and J2 or better near vision to be satisfied. His survey found that 68% of the monovision patients in his study never wore distance glasses, despite being advised to wear them for driving. Similarly, the average distance vision spherical equivalent in Jain et al[4] was -0.04 ±0.27D, the average near vision spherical equivalent was -1.95 ±0.70D, and 88% of patients in their study were satisfied with these results.

RATES AND MEASURES OF SUCCESS

After full consideration of all the factors influencing the modality's success, Miranda et al[1] found the acceptance rate of monovision with LASIK to be 92.5%. The investigators noted that the rate was highest for patients older than 53 years of age with a targeted outcome of -1.50 to -2.00D. On the other hand, Jain et al[4] found that patients' overall rate of satisfaction was 88%, although it was not significantly related to their age, gender, preoperative contact lens trial, amount of anisometropia, or type of monovision. Although the patients who had full distance correction reported somewhat higher levels of postoperative satisfaction than the monovision patients, the differences were not significant in Goldberg's survey (P=.41).[2]

All studies reported satisfaction rates higher after refractive surgery monovision than the published 76% success rate of contact lens monovision reported by Jain et al[6] in 1996. Greater postsurgical satisfaction supports the notion that surgical monovision is more successful than contact lens monovision. Although the reasons for this difference are unclear, they may include (1) surgery's producing constant optical correction, which facilitates cortical adaptation, (2) residual astigmatism with contact lenses, and (3) patients' freedom from contact lenses after surgery.

THE BOTTOM LINE

Monovision presents a viable option for presbyopes considering refractive surgery. A thorough explanation of visual expectations and adaptation—perhaps followed by a simulation with a contact lens—as well as an extensive evaluation of the factors influencing the modality's success are necessary for identifying appropriate candidates for this form of correction. ■

Reviewer

Dr. Boerman may be reached at (615) 321-8881; drboerman@wangvisioninstitute.com.

Panel Members

Y. Ralph Chu, MD, is Medical Director, Chu Vision Institute in Edina, Minnesota. Dr. Chu may be reached at (952) 835-1235; yrchu@chuvision.com.

Wei Jiang, MD, is a resident in ophthalmology at the Jules Stein Eye Institute in Los Angeles. Dr. Jiang may be reached at (310) 825-5000; wjiang70@yahoo.com.

Baseer Khan, MD, FRCS(C), is a fellow of glaucoma and anterior segment at the University of Toronto. Dr. Khan may be reached at (415) 258-8211; bob.khan@utoronto.ca.

Gregory J. McCormick, MD, is a cornea and refractive fellow at the University of Rochester Eye Institute in New York. Dr. McCormick may be reached at (585) 256-2569; mccormick_greg@hotmail.com.

Lav Panchal, MD, is Clinical Instructor in the Ophthalmology Department at the University of Tennessee, and a Cornea and Refractive Surgeon at the Wang Vision Institute in Nashville, Tennessee. Dr. Panchal may be reached at (917) 751-8651; drpanchal@wangvisioninstitute.com.

Jay S. Pepose, MD, PhD, is Professor of Clinical Ophthalmology & Visual Sciences, Washington University School of Medicine, St. Louis. Dr. Pepose may be reached at (636) 728-0111; jpepose@peposevision.com.

Paul Sanghera, MD, is a senior resident in ophthalmology in the Department of Ophthalmology and Vision Sciences at the University of Toronto. Dr. Sanghera may be reached at (416) 666-7115; sanghera@rogers.com.

Renée Solomon, MD, is an ophthalmology fellow at Ophthalmic Consultants of Long Island in New York. Dr. Solomon may be reached at reneeoph@yahoo.com.

Tracy Swartz, OD, MS, may be reached at (615) 321-8881; drswartz@wangvisioninstitute.com.

Ming Wang, MD, PhD, may be reached at (615) 321-8881; drwang@wangvisioninstitute.com.