Presbyopia correction is still an elusive goal in ophthalmology. Although there are several available methods that achieve improvements, including monofocality, multifocality, refractive lens exchange, scleral expansion, lens modification, and newer methods such as presby-LASIK and IntraCor (Technolas Perfect Vision, Heidelberg, Germany) we have yet to identify a gold-standard treatment. In my practice, I have found that patients accept monovision as a viable option to treat their symptoms of presbyopia.

Monovision with contact lenses or IOLs has been a long-standing approach to presbyopia correction, with varying success rates due to contact-lens intolerance and poor adaptation to monovision. More recently, refractive surgeons have begun to use monovision LASIK to artificially correct one eye (normally the dominant) for distance vision and the other for near vision. Correcting the dominant-sighted eye for distance improves activities such as walking and driving and produces smaller esophoric shifts at distance.

Additional Ablation If Necessary

Refractive monofocal surgery as a modality for presbyopic correction has a relatively high success rate; in a recent study of 748 eyes (374 patients), we concluded that 92.5% of patients accepted monovision after LASIK treatment.1 The success rate of monovision with contact lenses is somewhat lower at 76%, based on a large review of the peer-reviewed literature.2 A multifocal corneal shape may contribute to the higher success rate of refractive monofocal surgery versus contact lens monofocality.

One of the main reasons we offer monovision refractive surgery is that we can easily make provision for an additional corneal ablation if the patient is dissatisfied with monovision. In this respect, monovision refractive surgery is a trial. Only 7.5% of patients in our study underwent an enhancement to eliminate their monovision. All were retreated to sustain distance vision in the nondominant eye. Such unhappy patients typically report a strong sighting preference, a significant reduction in stereo acuity, minimal interocular blur suppression, and large esophoric shifts.1 In rare cases, crossed monovision (ie, undercorrection of the dominant eye, producing near vision, and overcorrection of the nondominant eye, producing distance vision) occurs.3 The second ablation may be performed any time after 3 months following the initial monovision LASIK procedure and does not induce significant surgical risks.

The success of monovision correlates with three principles: (1) accuracy of distance correction in the dominant eye, (2) less than 50 seconds of arc stereoacuity reduction, and (3) less than 0.60 prism diopters of distance esohoric shifts.

When monovision works, it can effectively increase functional vision without the aid of glasses and eliminate the corollaries of presbyopia. However, monovision may also significantly reduce binocular contrast sensitivity with spatial frequencies greater than 4 cycles per degree; reduce task performance by 2% to 6%; and minimally reduce binocular visual acuity, peripheral visual field width, and depth of focus.1,4 For these reasons, patient selection is crucial. Clinical screening processes must be set in place to evaluate the potential success of monovision.

Patient Selection

When deciding which patients will accept monovision, the first consideration is attitude. Does the patient show the desire to pursue and maintain monovision correction as an endpoint? Additionally, patients should understand that correcting one eye for distance vision may increase the likelihood for an enhancement versus bilateral distance vision correction.

During the screening examination and work-up, the technician introduces the concept of monovision and shows the benefit versus detriment with trial frame simulation. The option is then again raised by the physician, who quotes the "greater than nine out of 10" success rate1 and option for no-cost retreatment after 3 months, should the monovision be deemed unacceptable. Patients are told that they essentially have a free trial of monovision for that time frame, and that their brain will increasingly learn to adapt and suppress the blurry image the longer they maintain monovision.

The motivation of the patient to achieve both distance and near vision with freedom from glasses for most of the day leads them to select the monovision laser trial.
Monovision contact lenses may also be tried, especially in hyperopes who would receive a greater laser vision correction, but the lower percentage acceptance of contact lens-induced monovision (76% vs 92.5%)\textsuperscript{1,2} gives the counseled patient enough incentive to proceed directly with monovision LASIK or PRK.

**PATIENT ACCEPTANCE**

Few studies have evaluated success rates in younger versus older presbyopes. In our study, we noticed that older patients did slightly better with monovision compared with younger patients (93.87% vs 88.23%, respectively; Table 1). Such results validate the aging population’s desire for spectacle independence. Perhaps younger patients who decided against monovision at a younger age will return in a few years to undergo surgical correction.

We also studied success rates in accordance with the range of correction. Patients receiving a myopic target of -1.50 to -2.00 D were more likely to accept monovision (94%) compared with patients receiving targets of -0.50 to -0.90 D or -1.00 to -1.40 D (88.23% vs 92.04%, respectively); however, the difference was not statistically significant.

In the cases where only one eye was treated to achieve monovision, the patient satisfaction rate was higher when only the nondominant eye received hyperopic treatment versus when the dominant eye received myopic treatment (100% vs 90%, respectively).

Although most surgeons conduct a contact lens trial for monovision, we offer the monovision LASIK procedure as the trial. If patients are not happy with the results, we simply schedule a second corneal ablation (at least 3 months later) to eliminate the monovision. Patients with hyperopia are offered a contact lens trial prior to surgery; however, it is not required. By omitting the contact lens trial in most patients,

<table>
<thead>
<tr>
<th>Acceptance of Laser-Targeted Monovision</th>
<th>Group 1 (-0.50 to -0.90 D)</th>
<th>Group 2 (-1.00 to -1.40 D)</th>
<th>Group 3 (-1.50 to -2.00 D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients (n)</td>
<td>40</td>
<td>265</td>
<td>49</td>
</tr>
<tr>
<td>Age (years)</td>
<td>43 ±6.5</td>
<td>48 ±6.7</td>
<td>57 ±5.9</td>
</tr>
<tr>
<td>Sex</td>
<td>17 F / 23 M</td>
<td>133 F / 132 M</td>
<td>20 F / 29 M</td>
</tr>
<tr>
<td>Acceptance</td>
<td>88.23%</td>
<td>92.04%</td>
<td>94.00%</td>
</tr>
</tbody>
</table>

**Table 1. Increasing Myopic Target and Trend Toward Greater Acceptance of Monovision with an Increasing Age**

Figure 1. Note the change in the wavefront spherical aberration (4,0) from a near-zero preoperative value to -0.72 µm postoperatively. This shift toward negative asphericity in hyperopic LASIK patients provides greater depth of field and possibly increases monovision acceptance in these patients.
we save the time associated with contact lens fittings. Additionally, contact lens trials are not 100% accurate and patients who did not adapt to monovision with contact lenses may still be good candidates for refractive monovision surgery.

The treatment plan is a consensus between surgeon and patient of what the desired outcome should be. We use the following approximate targets: for patients younger than 43 years of age, we target between -0.50 and -1.00 D; from 44 to 48 years of age, we target -1.00 to -1.25 D; from 49 to 52 years of age, we target -1.25 to -1.50 D; and for patients 53 years or older, we target -1.50 to -2.00 D.

**ANISOMETROPIA**

The level of anisometropia induced by monovision is usually well tolerated by the patient, especially when they are able to adapt to it over a long period of time. However, differences in spherical refraction greater than 1.75 D between eyes can sometimes be poorly tolerated, especially in the beginning, so that the patient may reject the monovision.

One of my patients, an architect from Central America, had hyperopic LASIK in his nondominant emmetropic eye for near correction. He received a -2.00 D refractive outcome in that eye and complained bitterly to me about headaches and eye strain induced by the anisometropia. I told him he needed to wait for his eyes to stabilize. He called me from Central America several times over the first 3 months, but after a while I did not hear from him. Recently, after 2 years, he came back to see me and told me about the difficulty he experienced. When I asked him if he wanted to get rid of his near vision, he emphatically said no. He now liked his near vision and after the 2 years had adapted to the monovision, even though he was miserable in the beginning. Had he been a local patient, he would have rejected the monovision early and sought a retreatment.

**TAKE-HOME MESSAGE**

- An additional corneal ablation may be performed after monovision refractive surgery if the patient is dissatisfied with monovision.
- When monovision works, it can increase functional vision without the aid of glasses and eliminate the corollaries of presbyopia; however, patient selection is crucial.
- Older patients do better with monovision compared with younger patients.
- Contact lens trials are not always accurate predictors of monovision tolerance.
months after surgery. Because he was from a distant location, he was forced to accept it and learn to adapt. The 2 years’ time for neural adaptation was sufficient to bring him to acceptance, whereas previously it was unacceptable. With enough time, even the most challenging patient can learn to adapt to monovision.

CONCLUSION

Some studies in the literature suggest that patient acceptance after refractive monovision surgery is between 72% and 88%, and the success rate increases if contact–lens–related failures are excluded. Although I choose to forego the contact lens trial in myopic patients older than 40 years of age, I have still been able to achieve patient acceptance in 92.5% of cases. The way I do this is by strategic patient counseling and simulation: (1) showing the near benefit of monovision with a trial frame, (2) quoting the “greater than nine out of 10” success rate and option for no-cost retreatment after 3 months should the monovision be deemed unacceptable, (3) telling patients that it is the most functional vision (Figure 1) I can give them in the second half of their life, and (4) explaining that their brain will increasingly learn to adapt and suppress the blurry image the longer they maintain monovision.

As the popularity of refractive surgery continues to grow, more middle-age patients will inquire about presbyopic correction. My experience has shown that until we achieve a true gold standard in presbyopia correction, monovision LASIK is an effective and reasonable therapeutic approach for these patients. I urge each surgeon to develop his own clinical screening methods and patient counseling strategies to include monovision refractive correction where appropriate. Although other procedures available outside the United States, such as aspheric hyperprolate corneal ablation, may be considered preferable by some, my own experience has shown that monovision laser vision correction is today’s most effective way to combat the frustrations of presbyopia in the aging population seeking refractive surgery.

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