Ever since 1677, when Descartes first observed the ability of the human eye to focus on objects at different distances in a visual field, physiologists and optical physicists have been fascinated by this phenomenon, but its mechanism has eluded them. Subsequently they learned that, with age, the human eye loses its ability to accommodate.

During the past 10 years, interest in presbyopic refractive surgery has grown among ophthalmologists and patients alike. But the key to success with refractive surgery to correct presbyopia is proper patient selection. This article reviews the presbyopic treatments available today and discusses proper patient selection.

**FIXED-FOCUS STATE**

The presbyopic eye is more or less in a fixed-focus state, meaning that it can see clearly only at one distance. Distance correction with glasses or contact lenses affords clear vision for distant objects, meaning the patient may read 20/20 on the distance vision eye chart but lose his ability to read clearly at near. On the other hand, when the patient is corrected for near (ie, reading vision), he will be able to see clearly up close but lose his ability to see distant objects clearly. Therefore, reading vision is gained at the cost of distance vision, and vice versa.

There has been impressive improvement in the surgical treatment of presbyopia in recent years, with a long list of current treatment options that include corneal surgery approaches such as monovision or multifocal LASIK, conductive keratoplasty, and now presby-LASIK; surgical reversal techniques, including scleral expansion bands, anterior ciliary sclerotomy, and laser; and intraocular techniques, including monovision and multifocal and accommodating IOLs.1-29

All options for surgical intervention have compromises or risks. For starters, the complications associated with corneal techniques can be summarized into four main areas: (1) the general risk of having surgery, (2) poor patient selection, (3) the risk for surgical error, and (4) malfunction of the device. For intraocular techniques, the disadvantage of multifocal IOLs is not a loss of visual acuity but rather image degradation from a loss of contrast sensitivity. Only one of the images produced by a multifocal IOL is in focus, and it is juxtaposed against an out-of-focus background image. As with multifocal contact lenses, the image in focus is more readily compromised by astigmatism, lens tilt, posterior capsular opacification (PCO), pupil dilation, and subclinical cystoid macular edema. Additionally, diffractive optics may be associated with more chromatic aberration, astigmatism, and coma than monofocal IOLs. On the other hand, if we look at the benefits of multifocal IOLs, unlike multifocal contact lenses, they are positioned close to the eye’s nodal point, they can be well positioned with little to no movement, and they do not suffer from the accumulation of protein and other debris on the lens.

**PATIENT SELECTION**

Before a patient considers presbyopic refractive surgery, the surgeon or staff should offer him some level of education. This process should include several factors: ensuring that the patient has realistic expectations; explaining the nature of the elective procedure; discussing the risks and benefits of surgical intervention, including the potential need for enhancement; and offering alternative corrections including spectacles, contact lenses, and other surgical procedures.

Proper patient selection is key to a successful presbyopic procedure. Try to select patients for multifocal IOLs who are motivated to reduce spectacle dependence. This is possibly the most significant factor to the final outcome, given that premium lens technologies require the patient to pay the additional cost. Consider performing intraocular pres-
byopic correction in candidates for bilateral implantation and in cataract patients who did not need to wear glasses until presbyopia set in. Other patient populations that may be appropriate for refractive presbyopic correction include those who had previously been interested in refractive surgery and those with visual demands under normal light levels and with normal reading materials.

Caution must be considered in patients who: (1) have unrealistic expectations for visual improvement, (2) have a history of excessive complaints with glasses and contact lenses, (3) drive at night as a profession, (4) are happy wearing glasses, (5) have preexisting problems with nighttime glare, or (6) have preexisting significant ocular surface disease.

It is extremely important to make IOL candidates aware of the possibility of glare and haloes. Note that these visual disturbances can occur with any type of IOL, not only multifocals. Experience has demonstrated that, with certain IOLs, residual astigmatism greater than 0.50 D affects quality of vision. This can be mitigated with limbal relaxing incisions (LRIs) or LASIK within as little as 90 days after surgery. A noninvasive alternative is the use of spectacles part time.

ENVIRONMENTAL VISION

Trying to simulate natural vision is an elusive goal. Thus, when correcting for presbyopia, we move away from super-vision and closer to functional or environmental vision. The hypothetical eye with super-vision optics will have such a small depth of focus that even mid-distance targets require an accommodative response to achieve an optimal retinal image. Functional vision is, to a great degree, related to the environment in which the patient lives and works. Environmental parameters can be broken up into five groups (Table 1), and the patient selection process should include discussion of which of these zones of distance are most important to the patient.

We should always suggest to patients that the best postoperative outcome is not super-vision but rather functional vision, physiologic vision, or environmental vision. We should aim to customize the best overall solution for each patient.

PREOPERATIVE EVALUATION

The following factors must be evaluated before refractive surgery, as they may lead to potential complications.

Unstable refractive error. Patients should be at least 21 years of age. (Some female patients will reach a stable refractive error before the age of 21 years but never before the age of 18 years.) Other sources of refractive instability include cataract development and corneal warpage secondary to long-term contact lens wear.

Pupil diameter. Patients with larger pupils are more likely than those with smaller pupils to notice existing higher-order aberrations, which may manifest as night-vision problems. Measure pupils under both photopic (or mesopic) and scotopic conditions and document results under dim illumination.

Corneal topography. Evaluate the surface contour of the cornea to determine the potential for early keratoconus.

Pachymetry. Patients must maintain a corneal thickness of at least 410 µm postoperatively. Ablation depth is determined by the diameters of the optical zone and blend zone and by the degree of refractive error.

Manifest and cycloplegic refractions. Measure the refractive error (ie, myopia, hyperopia, astigmatism) to protect against over-correction.

Cover test. A cover test should be performed to rule out strabismus; patients with intermittent strabismus may not tolerate monovision corrections.

Tear film assessment. Significant dry eye may delay healing and decrease visual acuity during early healing. Test for reduced tear quantity using the Schirmer tear test (ie, less than 8 mm corneal or less than 15 mm conjunctival). Test for corneal staining using rose bengal, lissamine green, or Schirmer tear test (less than 8 mm). Test for conjunctival staining alone using rose bengal dye, lissamine green, or Schirmer tear test (less than 15 mm). Treat any dry eye identified by these tests pre- and postoperatively with artificial tears, punctal occlusion, or both.

Slit-lamp examination. Patients with blepharitis and meibomian gland dysfunction are more than twice as likely to experience dry eye as patients without these conditions. They also have more symptoms postoperatively. The presence of staphylococcal bacteria in these conditions poses a risk for infection during refractive surgery. Intrastromal scars may result in an irregular ablation rate, and large pingueculae may increase the difficulty of obtaining proper

**TABLE 1. ENVIRONMENTAL FACTORS FOR CONSIDERATION IN PRESBYOPIC CORRECTION**

<table>
<thead>
<tr>
<th>Distance Zone</th>
<th>Visual Activities</th>
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<tbody>
<tr>
<td>30 to 50 cm</td>
<td>Newsprint, phonebook, stock exchange listings, maps, make-up, sewing</td>
</tr>
<tr>
<td>50 to 100 cm</td>
<td>Headlines, computer work, reading, playing cards, reading menus, shopping</td>
</tr>
<tr>
<td>100 to 250 cm</td>
<td>Indoor work, television, cooking, clocks, meals, cleaning</td>
</tr>
<tr>
<td>200 to 2,500 cm</td>
<td>Daytime outdoor activities, far vision, driving, golf, tennis, sightseeing, reading road signs</td>
</tr>
<tr>
<td>Greater than 2,500 cm</td>
<td>Nighttime distance vision, night driving, movies, theater, reading by candlelight</td>
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suction during flap creation with a microkeratome.

Dilated fundus exam. A thorough peripheral fundus examination is required to rule out retinal thinning, macular holes, or partial detachments that could lead to potential problems during refractive surgery.

Monitoring IOP. Monitoring should include several IOP measurements taken at various times. Tests and measurements should include central corneal thickness, IOP measurements taken at various times. Tests and measurements should include central corneal thickness, baseline optic nerve and/or nerve fiber layer imaging, visual field studies, and baseline gonioscopy (especially for hyperopic patients). It is important to educate the patient that lifelong follow-up and glaucoma surveillance are mandatory.

Objective assessment of optical quality. Wavefront aberrometry measures total optical aberrations, including not only spherocylindrical refractive error but also spherical aberration, trefoil, coma, secondary astigmatism, and other higher-order aberrations described by Zernike polynomials. Such higher-order aberrations are thought to contribute more than 20% of the total aberrations in a normal eye and possibly a much greater percentage of aberrations in eyes with keratoconus or previous surgery.

FOLLOW-UP AND PATIENT SELECTION PEARLS

Follow-up. Postoperative visits for comanagement of presbyopic refractive surgery patients should be performed at 1 day, 1 week, 1 month, 3 months, and 9 to 12 months or as needed postoperatively.

Patient selection pearls. When identifying candidates for presbyopic correction, remember these points:

1. Consider patient psychology (ie, know the patient’s lifestyle and visual expectations);
2. Favor candidates with a low concern for perfect contrast vision, with a slight tolerance for unwanted visual phenomena such as halos, and with good personalities;
3. Those who desire perfect distance vision are less suitable;
4. Pupil size matters;
5. Keep at minimum 1 week between surgeries in the patient’s two eyes; and
6. Above all else, primum non nocere (ie, first do no harm).

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