

# Premium Performance in an Intermediate World



- Study Finds Accommodative IOLs Provide Long-Term Stability
- Premium IOLs Deliver the Visual Outcomes Patients Desire
- How Increased Life Span Affects IOL Choice
- Quality of Vision Metrics Show Accommodative Lenses Outperform Multifocals

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# The Longevity Revolution

Reviewing the impact of increasing lifespan on the choice of lifestyle-enhancing intraocular lenses.

Life expectancy in the United States has increased dramatically.<sup>1</sup> Individuals born in the U.S. in 1900 had a life expectancy of 47.3 years versus nearly 78 years today — a 64% increase.<sup>2</sup> Increased life expectancy and a comparatively more energetic lifestyle means that the average American can expect to live 20-25% of our lives in active retirement.

The first wave of baby boomers reached retirement age this year and 10,000 baby boomers will reach age 65 every day for the next 19 years. The fastest growing segment of the population is comprised of those over the age of 85 — with a growth rate twice that of those 65 to 74 and nearly four times that of the entire population. This segment now represents 10% of those over age 65 and will more than triple from over 5.7 million this year to 19 million by 2050. This article analyzes the significance that this increase in longevity may have when selecting a presbyopia-correcting IOL.

## Reduced Contrast Sensitivity and Aging

Contrast sensitivity is an essential component of pattern recognition.<sup>3</sup> Good contrast sensitivity is integral to performing many daily tasks and functions, such as discerning facial expression, descending stairs and pouring coffee.

Just as the performance of an athlete generally declines with advancing age, contrast sensitivity also declines with each decade of life.<sup>3,4</sup> This age-associated loss is the cumulative result of advancing lenticular density, ocular scatter, progressive miosis, senescent neural changes, ocular aberrations and loss of the youthful offset of positive corneal spherical aberration by the aging lens.<sup>3-9</sup>

Recent studies by Hayashi and colleagues<sup>10</sup> confirm that contrast sensitivity decreases with each decade of life, even in

pseudophakes tested at the same pupil size. This study of contrast sensitivity and age in patients with pseudophakos thereby controls for confounding age-related changes in the crystalline lens that can also reduce contrast thresholds. It further substantiates that there is an independent reduction in the neural aspect of spatial contrast resolution with advancing age, negatively impacting an essential component of pattern recognition.

The effect of reduced contrast sensitivity on a complex task, such as night driving, is further compounded by other age-related deficiencies in visual processing. Age is associated with reduced contrast sensitivity to low spatial frequency targets presented under rapid temporal modulation (e.g. flicker), prolonged time for dark adaptation, impaired motion perception and slower visual processing speed.<sup>3</sup> The latter refers to older individuals requiring more time than younger ones to detect, discriminate, recognize or identify visual targets. Slower visual processing speed has been associated with a greater automobile crash risk<sup>11-13</sup>, and fall risk, and motility problems, such as transitioning from sitting to standing and requiring increased time to complete typical everyday visual tasks.<sup>3</sup>

## Reduced Contrast Sensitivity and Ocular Disease

There are a number of ocular diseases that negatively influence contrast sensitivity. Recent studies<sup>14,15</sup> of

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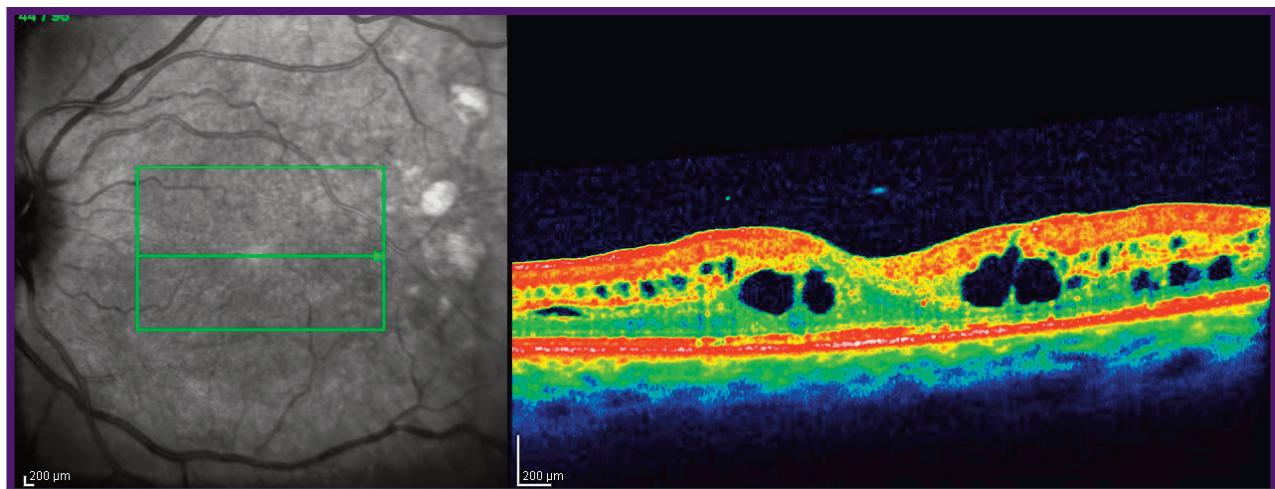


Figure 1. OCT demonstrates diabetic macular edema. Reduced contrast sensitivity can be detected even prior to retinal changes becoming visible on OCT or ophthalmoscopy.

diabetic patients show a decrease in foveal contrast sensitivity independent of lens changes and prior to the detection of structural retinal changes on OCT or fundus biomicroscopy. Glaucoma has also been shown to decrease foveal contrast sensitivity,<sup>16</sup> while AMD,<sup>17</sup> myopic degeneration and epiretinal membranes (ERM) all reduce contrast.

A healthy tear film has sufficient surface tension to mask the many microscopic irregularities of the ocular surface. Dry eye syndromes unveil these irregularities, resulting in both ocular scatter and higher-order aberrations.

nosed. As the U.S. population ages, the impact of diabetes and diabetic retinopathy (Figure 1) will intensify, even more so if there's not a reversal of the obesity epidemic.<sup>18</sup> Of particular import, the largest increases in diabetes are expected among adults over 75 years, projected to affect 4.4 million women and 4.2 million men by 2050. As mentioned previously, diabetes negatively impacts contrast sensitivity independent of lens changes prior to the onset of detectable retinal pathology on ophthalmoscopy or OCT imaging.<sup>14,15</sup>

It is estimated that AMD, which compromises contrast sensitivity, is the cause of 54.4% of overall visual impairment among Caucasians. The Beaver Dam Eye Study<sup>19</sup> revealed that the 15-year cumulative incidence of early AMD in those over 75 years of age at baseline is 24%. The AREDS study<sup>20</sup> found that 20.2% of individuals with early stage AMD progressed to advanced disease over a 5-year period at a rate of 4.0% per year.

During a 12.7-year follow-up, 40.6% of highly myopic eyes developed progression of the myopic maculopathy, including diffuse atrophy, lacquer cracks and choroidal neovascularization.<sup>21</sup>

The Beaver Dam study<sup>22</sup> showed that the prevalence of glaucoma increased with age from 0.9% in people 43 to 54 years of age to 4.7% in people 75 years of age or older.

**No matter how careful one may be in preoperative examination and testing, it is not possible to accurately foretell whether a cataract patient will develop future ocular comorbidities.**

#### Prevalence of Age-related Ocular Diseases That Reduce Contrast Sensitivity

Diabetes affects approximately one in five (18.7%) persons aged 65 or greater, many of whom are undiagnosed.

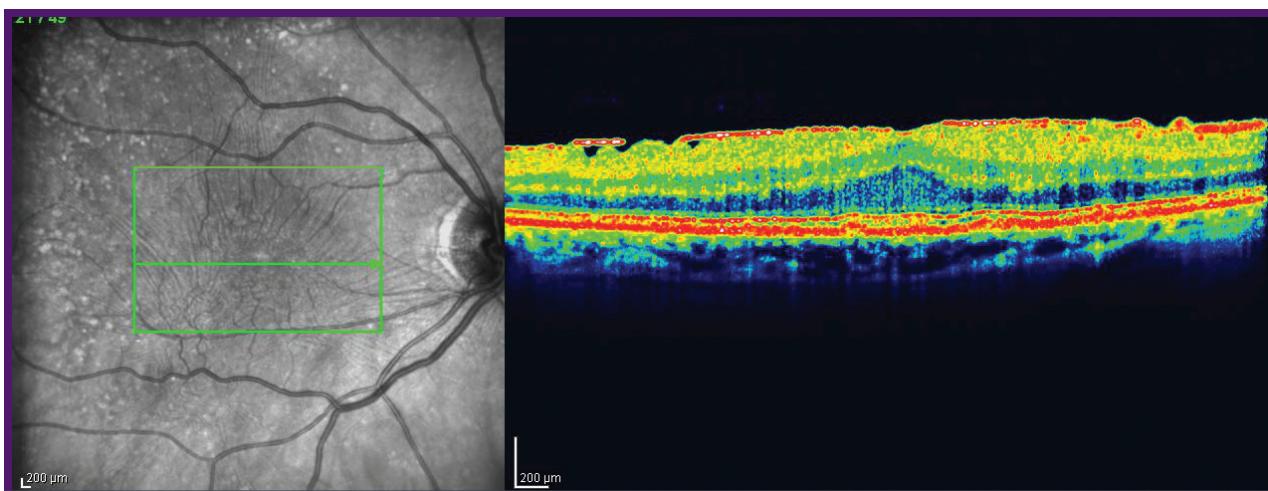


Figure 2. An epiretinal membrane is demonstrated by OCT, with concomitant retinal distortion. Even gossamer thin epiretinal membranes can be associated with reduced contrast sensitivity.

The prevalence of dry eye also increases with age, affecting 5.7% of women greater than 50 years old versus 9.8% of women greater than 75 years old. The age-adjusted prevalence of dry eye in women at least 50 years of age was 7.8% or 3.23 million women in the United States.<sup>23</sup>

### Preoperative Screening

It may be possible to attempt to prescreen for macular pathology, glaucoma and dry eye prior to cataract extraction. The use of a Retinal Acuity Meter (AMA Optics) may be helpful in detecting functional deficiencies in potential retinal acuity in cataract patients with 20/200 vision or better.<sup>24</sup> OCT scans of the retina and optic nerve may help in the detection of maculopathies, epiretinal membranes (Figure 2) and glaucoma. For example, of 45 patients referred for cataract extraction prospectively evaluated by OCT, epiretinal membranes were noted in 7 (15.6%). Most ERM (particularly cellulophane maculopathy) were not visible by ophthalmoscopy alone. Visual acuity in eyes with ERM was worse than in contralateral eyes without.<sup>25</sup>

Dry eye testing by determination of tear osmolarity, vital dye staining and tear break up time may detect the presence of dry eye syndromes and its effect on visual function.<sup>26</sup>

### Ocular Disease Following Cataract Extraction

No matter how careful one may be in preoperative examination and testing, it is not possible to accurately foretell whether a cataract patient will develop future ocular comorbidities. A prospective study<sup>27</sup> of patients 2 years following cataract extraction shows that new

systemic disease affected 18.4% of patients and that new ocular disease (other than posterior capsular opacity) affected 7.2%. Another prospective study<sup>28</sup> following patients 2 years after uncomplicated cataract extraction indicated that a loss of 2 lines or more of pinhole visual acuity was associated with the following comorbidities besides PCO: AMD, glaucoma, diabetic retinopathy, branch retinal vein occlusion, epiretinal membrane, macular hole, myopic retinopathy and optic atrophy.

It is clear that the prevalence of macular degeneration, myopic degeneration, epiretinal membranes, diabetic retinopathy, glaucoma and dry eye will increase with ensuing years following cataract surgery, and that some of these conditions may require additional surgical intervention. There are three reports in the literature<sup>29-31</sup> describing difficulty in visualizing the retina during vitreoretinal surgery and epiretinal membrane peeling in patients implanted with refractive and diffractive multifocal IOLs.

### Impact of Increasing Life Span on Choice of Lenses

We have established that a number of prevalent age-related diseases reduce contrast sensitivity, that age itself reduces neural contrast sensitivity even in pseudophakes, and that pupil size generally decreases with each decade of age.<sup>32</sup> How might these factors impact the choice of presbyopia-correcting IOLs?

The distribution of light energy between near and far foci (and useless foci) with apodized diffractive IOLs such as Restor (Alcon) will vary dramatically based on photopic and mesopic pupil size, shape and dynamics. For example, the performance of a Restor 3.0 IOL in a patient implanted at age 59 with a pupil

diameter that ranges from 6 mm when night driving and 3 mm when reading in moderate light may be quite different when that patient turns 79 and has a pupil that is 2.5 mm in ambient lighting, 1.5 mm

sensitivity as compared to a monofocal IOL may be experienced by some patients and may be more prevalent in low lighting conditions. Therefore, multifocal patients should exercise caution when driving at night or in poor visibility conditions.”

## **As an accommodating IOL, Crystalens AO does not split light between multiple foci or reduce contrast sensitivity as compared to a multifocal IOL.**

when reading and 3.5 mm when driving at night. The effect of progressive “senile” miosis and changes in pupil dynamics with each decade of life must be factored into the future performance of some multifocal IOLs. While aggregate data<sup>32</sup> describes average age-related reduction in pupil size, it is difficult to anticipate the effect of age, future medications or systemic diseases on an individual patient’s pupil size and dynamics with any degree of certainty.

Whereas family history of ocular disease, concurrent systemic diseases, genetic markers and habits such as smoking may represent assessable risk factors for developing some ocular co-morbidities, such as AMD, it’s not possible to know with a high degree of certainty whether a 68-year-old patient with no signs of AMD or epiretinal membrane may develop these conditions over the next 10 years (i.e., the current average U.S. life expectancy). We do know that as an independent variable, advancing age itself reduces contrast sensitivity, dark adaptation, temporal sensitivity, motion detection and visual processing speed.

In considering IOLs that may further reduce this waning contrast sensitivity, the FDA has placed the following warning label on the package insert of multifocal IOLs: “Some visual effects may be expected due to the superposition of focused and unfocused multiple images. These may include some perceptions of halos or radial lines around point sources of light under nighttime conditions. A reduction in contrast

### **Factoring Uncertain Risks Into the Choice of an IOL**

Given the extended life expectancy currently enjoyed in the United States,<sup>1</sup> along with the increased prevalence of age related ocular co-morbidities that may further reduce contrast sensitivity, how should these factor in when choosing between multifocal IOLs that further reduce contrast sensitivity<sup>33,34</sup> as compared to an accommodating IOL (e.g. Crystalens AO), which does not?

Different presbyopia-correcting IOLs have exploited varying strategies to enhance depth of focus. These are associated with different compromises with regard to near and intermediate visual acuity, halos, optical scatter and other aspects of visual quality.<sup>35</sup> Each IOL has inherent strengths and weaknesses and possesses iterative improvements in comparison to their predecessors. When choosing a specific presbyopia-correcting IOL, the surgeon must assess the patient’s current condition and also try to predict future comorbidities in deciding whether to implant an IOL that may reduce contrast sensitivity in exchange for greater depth of focus. As an accommodating IOL, Crystalens AO does not split light between multiple foci or reduce contrast sensitivity as compared to a multifocal IOL. As far as concerns about the potential impact of changes in the capsular bag with age on the mechanism of action of Crystalens, long-term studies by Drs. Doane and Colvard of the performance of Crystalens at 3 and 7 years post-implantation show no diminution of effect at intermediate or near vision.

We are enjoying the benefits of the “Longevity Revolution.” In weighing the risks and benefits of multifocal versus accommodating IOL options, we need to consider the effect of our patient’s increased life span along with the increasing risk of developing ocular comorbidities that may both conspire to reduce contrast sensitivity.

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