Experts discuss current data of three light-filtering IOL technologies.

BY PENNY ASBELL, MD, FACS, MBA; SOM PRASAD, MS, FRCS(Ed), FRCOphth; AND ALBERT J. AUGUSTIN, MD

Several light-filtering IOL technologies are available to surgeons today. *Cataract & Refractive Surgery Today Europe* asked three practitioners to review the characteristics of three currently available light-filtering IOL technologies. Each surgeon responded independently to the same series of questions: (1) How does scotopic vision with this lens compare to UV-only–filtering IOLs? (2) How do contrast sensitivity results with this lens compare to UV-only–filtering IOLs? (3) How does color testing with this lens compare to UV-only–filtering IOLs? (4) For what types of patients would you recommend this lens? (5) What types of patients should be considered contraindicated for this lens? (6) What factors other than its light-filtering properties make this a preferred lens for your practice?

Answers for each IOL are presented side-by-side to allow comparison.

**HOYA AF-1 (UY)**

PENNY ASBELL, MD, FACS, MBA

1. In two recent studies,1,2 no significant differences in visual acuity results were found between the Hoya AF-1 (UY) blue-blocking IOLs and Hoya standard AF-1 (UV) UV-blocking IOLs (both manufactured by Hoya Healthcare Corp., Tokyo, Japan) under photopic conditions. Color vision was reduced1 (but not significantly) under scotopic conditions for the Hoya blue-blocking IOLs.

2. Contrast sensitivity testing using Early Treatment of Diabetic Retinopathy Study (ETDRS) and a Ginsburg functional acuity test (FACT)1 and color contrast sensitivity testing using the Moorfields Vision system2 showed no differences in contrast sensitivity between Hoya blue-blocking IOLs and Hoya standard UV-blocking IOLs.

In another study,3 in which contrast sensitivity was measured under conditions of glare and chromatopsia using the Multivision Contrast Tester (Vistech Consultants, Dayton, Ohio), the yellow-tinted Hoya lenses were superior to standard UV-filtering lenses.

3. In the Color Vision substudy data from the US Investigational Device Exemption for the Hoya blue-blocking lens, using the Farnsworth D-15, there were no statistically significant differences between the test and control population at 6 months.4

4. All patients who qualify for cataract surgery/IOL implant are candidates for this lens. Patients who have a need for precise vision under mesopic or scotopic conditions should be informed of the blue-blocking characteristics of the IOL.

5. Only those who are known to not be able to tolerate reduced color vision under any circumstances may be considered contraindicated for this IOL.

6. The Hoya lenses are offered in Europe preloaded in a disposable injector configuration that requires no folding or loading of the lens. Preloaded Hoya IOLs can be inserted through incisions as small as 2.5 mm. Alternatively, the Hoya IOLs can be easily folded and inserted through a 3-mm incision using a standard cartridge and injector. The Hoya IOLs are made from hydrophobic acrylic material with more than 7 years of clinical implant experience with no material-related adverse effects. The Hoya IOLs made from AF-1 material have a square edge to inhibit posterior capsular opacification (PCO). The material is biocompatible, stable, and exhibits less glare and glistenings than the AcrySof material (Alcon Laboratories, Inc. Fort Worth, Texas).

**VIOLET SHIELD**

SOM PRASAD, MS, FRCS(Ed), FRCOphth

1. A violet-blocking IOL should not affect scotopic vision to any significant extent. Violet light does not provide useful scotopic vision, and therefore there is no reason to believe that a violet-blocking IOL will perform differently from a UV-only–filtering IOL. In studies we have done comparing the Soflex IOL (Violet Shield; Bausch & Lomb, Rochester, New York) and the SofPort AO (Violet Shield and aberration-free optics), both IOLs performed well for scotopic vision.

On the other hand, blue light is responsible for approximately 40% to 45% of scotopic vision. Because of this, there is a potential that a blue-blocking IOL may be detrimental to scotopic vision. While the practical implications of this are unclear, and there are a plethora of poorly understood
factors about the quality of vision after implantation of various IOLs, the guiding principle of surgical intervention must remain, “First, do no harm.” I prefer a violet-blocking IOL as my routine lens, rather than a blue-blocking one. Concerns have also been raised about the effect of blocking blue light on circadian rhythms.

2. Violet light has little visual importance, and thus contrast sensitivity is not affected by using a violet-blocking IOL compared with a UV-only–filtering IOL. While I have not formally compared contrast sensitivity in Violet Shield versus UV-only–filtering IOLs, we have studied contrast sensitivity after implantation of the Violet Shield IOL, and it performs well.

3. Color testing should not be different between these two types of IOLs.

4. I use a violet-blocking (400-440 nm) IOL as my standard lens for the vast majority of cataract patients. I believe there is no practical difference in visual quality between a UV-only–filtering lens and a violet-blocking IOL, and blocking the violet wavelengths may be protective without any detriment to quality of vision.

5. I do not use a violet-blocking IOL in patients who require special implants such as toric or multifocal IOLs, or where an acrylic material is specifically indicated, such as in eyes in which silicone oil is being used simultaneously for retinal pathology. This is not because a violet-blocking IOL is contraindicated but because violet-blocking technology is currently unavailable in these types of lenses. If there is an overriding need for a specific type of implant, I am happy to use it without the violet-blocking technology.

6. The current SofPort AO has a 360° square edge, which reduces risk of PCO. The injector is user-friendly. I prefer a fully disposable injector, and my scrub team finds it easy to load this lens. The lens emerges from the injector in a relatively flat configuration, unlike some other systems where the IOL emerges in a rolled-up position and then unfurls in the eye. This may not make a practical difference for the majority of routine cases; however, in eyes with an unstable capsular bag this can be a great advantage.

I also appreciate the aberration-free design of this IOL. My main practice is in a multisurgeon training unit in a government (National Health Service) practice. Logistically, it is not practical to measure aberration and customize an aberration-correcting design in this setting, and because of this, although I appreciate that the ideal situation would be to choose an aberration-free or an appropriate aberration-correcting IOL based on preoperative evaluation, we prefer a zero-aberration design for our standard IOL. This may undercorrect aberrations in patients by not compensating for their corneal aberrations, but it also does not run the risk of making aberrations worse in some patients, which would be the case if we used an aberration-correcting IOL design without the facility to customize.

ACRYSOF NATURAL
ALBERT J. AUGUSTIN, MD

1. In natural lighting conditions, patients will not perceive any difference between an AcrySof Natural blue-light–filtering IOL (Alcon Laboratories, Inc.) and a UV-only–absorbing IOL in terms of scotopic vision. Because rod sensitivity peaks at 507 nm, theoretically blue-light–filtering lenses may adversely affect scotopic vision. The AcrySof Natural transmits approximately 85% of light in the 507-nm range. This is similar to the light transmission characteristics of a child’s crystalline lens. With 90% at about 500 nm, UV-absorbing lenses transmit only insignificantly more light. Hence, the comparison of transmission characteristics of UV-blocking and AcrySof Natural filtering shows that there is not even a theoretical probability that blue-light–filtering impairs scotopic vision to a clinically relevant extent.

Accurate calculations of the effect of blue-light–filtering on scotopic vision, along with the results of recent clinical studies, confirm these theoretical considerations. In an interindividual comparative study of 76 patients, Mutluoglu and colleagues found no significant difference in contrast sensitivity, under either photopic or scotopic conditions, between two patient groups—one implanted with blue-light–filtering IOLs and the other with conventional UV-blocking IOLs. It follows that the AcrySof Natural does not compromise scotopic vision; neither does a UV-blocking lens provide any benefits in this respect.

The results of another prospective randomized comparative study on the quality of life after cataract surgery (291 patients) show that blue-light–filtering IOLs do not compromise vision in dim light: postoperative driving in daylight, at night and in poor light conditions was statistically significantly better than before surgery both in patients with blue-light–filtering IOLs and in patients with UV-only–filtering IOLs. The same was true for negotiating stairs, steps, and curbstones; no statistically significant difference could be observed between the two patient groups.

2. Several clinical studies have shown that both UV-blocking and blue-light–filtering IOLs significantly improve contrast sensitivity in comparison with preoperative status. In doing so the AcrySof Natural appears to restore almost natural contrast vision. In a prospective randomized study, Bhattacharjee and colleagues found that contrast vision of patients with blue-light–filtering IOLs was closer to that of similarly aged patients with clear crystalline lenses, while the performance of patients with UV-only–filtering IOLs was slightly inferior.

In an admittedly small patient number (n=19), Leibovitch and colleagues found no difference in Pelli-Robson contrast sensitivity even under mesopic conditions (3 lux) between patients with blue-light–filtering lenses and those with conventional UV-blocking lenses. Additionally, in a study in 22 diabetic patients, the AcrySof Natural provided significantly
CATARACT MINI FOCUS ON HIGH-TECHNOLOGY MONOFOCAL IOLS

better contrast sensitivity than a UV-blocking lens in this patient group.

3. Numerous investigations have shown that no impairment of color vision can be attributed to the AcrySof Natural. Nevertheless, blue-light–filtering IOLs, depending on their transmission curves, absorb some light between 400 and 500 nm, a fact that has triggered discussion of possible color vision disturbances. A prospective study, using the FM-100 hue test to provide a detailed evaluation of color perception, showed no difference in color vision between patients with AcrySof Natural or UV-blocking AcrySof. Also, a comparison with age-matched patients with clear crystalline lenses revealed no significant changes in the color perception of patients implanted with AcrySof Natural.

In another randomized, double-masked study by Vuori and Mäntayjärvi,9 the AcrySof Natural did not affect color vision, according to the authors, interestingly not even in the blue spectrum. Likewise, a recently published randomized study was also unable to corroborate the deterioration of preexisting color vision defects that often is presumed to be associated with the implantation of blue-light–filtering IOLs. In contrast, in diabetic patients the blue-light filtering of the AcrySof Natural improved color vision in the blue-yellow chromatic axis (Figure 1).8

In daily clinical practice we make the following observation, which is of course far from being evidence-based research: Patients with blue-light–filtering IOLs usually feel comfortable with their color perception, while patients with UV-only–filtering IOLs sometimes notice cold and bluish colors. This is not the result of a trial but rather a clinical observation.

4. I recommend this lens for patients at high risk for progression of age-related macular degeneration (AMD); that is, many cataract patients above the age of 70 years. However, recent findings advise considering the implantation of a blue-light–filtering IOL even in younger patients, depending on their constitution and lifestyle.

According to results from epidemiology and biochemistry, there are two major reasons for implanting a blue-light–filtering IOL. First, it is common knowledge that blue light induces phototoxic damage to the retina. Second, findings from several epidemiological studies, although admittedly inconsistent, have shown that AMD progresses more frequently after cataract surgery. Up to 90% of elderly cataract patients suffer from macular alterations; those patients should be implanted with a blue-light–filtering IOL to reduce the risk of AMD progression.

Recent subgroup evaluations of the Beaver Dam population10 show that young patients, without any macular alteration so far, might become patients at high risk in the future. For instance, if a patient experienced more than 10 severe sunburns within a certain period of time, the risk of developing soft drusen during aging is significantly increased. These findings should be taken into account while considering the appropriate IOL for refractive surgical patients. It may thus also be prudent to implant such IOLs in the eyes of blond, blue-eyed persons. Additionally, we may consider that a longer life span extends the exposure time to blue light, thus making the retina more susceptible. However, this is speculative and needs confirmation in prospective trials.

5. So far I do not see any contraindications for implanting the AcrySof Natural. Many prospective studies and case series have shown that blue-light–filtering IOLs have no clinically significant effect on physiologic parameters such as scotopic vision, color, and contrast vision.

Even in patients with preexisting color vision defects, no impairment is detectable, and diabetic patients actually seem to benefit from blue-light–filtering IOLs with respect to color vision and contrast sensitivity, although these results must be further evaluated.

Moreover, according to the experience in our department and my personal communication with other vitreoretinal surgeons, the AcrySof Natural filter does not impair visualization of retinal pathologies, either in the retinal periphery or in the macular area. Therefore, patients who may under-
The Hoya AF-1 (UY) showed no difference from or better performance than a standard UV-blocking IOL in contrast sensitivity, functional acuity, and other tests.

The Violet Shield IOL performs well in contrast sensitivity testing and blocks violet but not blue light from reaching the retina. It incorporates an aspheric neutral design.

The AcrySof Natural showed no reduction of contrast sensitivity under scotopic vision and no effect on color vision.

go vitreoretinal surgery are not contraindicated for this lens.

6. AcrySof IOLs have been implanted in more than 30 million eyes. Due to its one-piece design, the lens is easy and comfortable to implant with an injector system through a 2.2-mm incision. It shows both good centration and long-term stability. The sharp-edged design effectively helps to reduce PCO and thus helps to provide good visual acuity in the long term. A recently published retrospective study in 31 eyes showed that 10 years postoperatively most patients did not suffer from PCO and the average BCVA was 0.88.

Penny A. Asbell, MD, FACS, MBA, is Editor-in-Chief of the Mount Sinai Journal of Medicine and a Professor of Ophthalmology and Director of Cornea and Refractive Services in the Department of Ophthalmology at Mount Sinai School of Medicine, New York. Dr. Asbell states that she is the Medical Monitor for US clinical trials of Hoya IOLs. She may be reached at tel: +1 212 241 7977; e-mail: penny.asbell@mssm.edu

Som Prasad, MS, FRCS(Ed), FRCOphth, is a Consultant Ophthalmologist and Clinical Director of the Eye Department at Wirral University Teaching Hospital NHS Foundation Trust, Wirral, United Kingdom. He may be reached at tel: +44 1516047193; e-mail: sprasad@rcsed.ac.uk.

Albert J. Augustin, MD, is the director of Augenklinik, Karlsruhe, Germany. He states that he has no financial interest with any products or companies mentioned in this article. Professor Augustin may be reached at tel: +49 721 9742001; e-mail: 106020.560@compuserve.com.


