

Cataracts, Contrast Sensitivity, and IOLs

The importance of preoperatively assessing potential retinal acuity in the premium IOL patient.

BY JAY S. PEPOSE, MD, PhD

Depending on its density and subtype, a cataract causes a variable reduction in both high-contrast visual acuity (ie, spatial resolution) and contrast sensitivity. Reduced contrast sensitivity, in part due to forward light scatter, is particularly problematic for the patient. It blurs all lines of the eye chart rather than just the lower lines as patients experience optical blur from an uncorrected refractive error (Figure 1). Although patients may still be able to decipher black letters against a backlit white background in the office, in the real world, they view objects composed of a wide range of spatial frequencies and illumination. Cataract patients with low contrast sensitivity function may have difficulty discerning facial expressions, seeing the edge of a curb, pouring liquids into a cup, reading in dim light, driving at dusk, and perceiving road hazards in a timely fashion.

Contrast sensitivity involves both optical and neurological processing and generally decreases with age. A number of ocular conditions besides cataract may reduce contrast sensitivity and/or high-contrast visual acuity. Broadly, these include maculopathies, retinal degenerations, optic neuropathies, and glaucoma, any of which can coexist with cataracts. An important challenge to the ophthalmologist, therefore, is to preoperatively diagnose these comorbidities and to counsel cataract patients on their potential retinal acuity, postoperative visual prognosis, and appropriate IOL options.

WHY ASSESS RETINAL ACUITY PREOPERATIVELY?

Patients considering a premium IOL have high expectations of postoperative uncorrected acuity at more than one focal plane. The substantial fee the patient pays for

the services associated with a deluxe lens raises the bar considerably with respect to the results of surgery. It is therefore particularly important to assess patients' retinal function preoperatively and identify those with associated comorbid retinal conditions such as premacular fibrosis and epiretinal membranes, macular degeneration, diabetic retinopathy, glaucoma, or optic neuropathies that can negatively impact the qualitative or quantitative visual outcome of cataract surgery with a premium IOL.

This valuable information allows the surgeon to obtain a more accurate informed consent about the planned procedure and its risks, benefits, and likely outcome. More precise informed consent helps to avoid a disappointing postoperative surprise. Patients with significant comorbid reti-

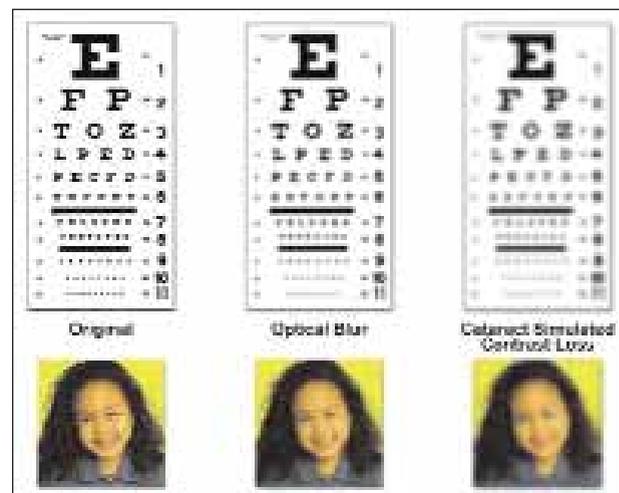


Figure 1. Cataracts can result in a loss of both high-contrast visual acuity and contrast sensitivity, with distortion of the entire eye chart.

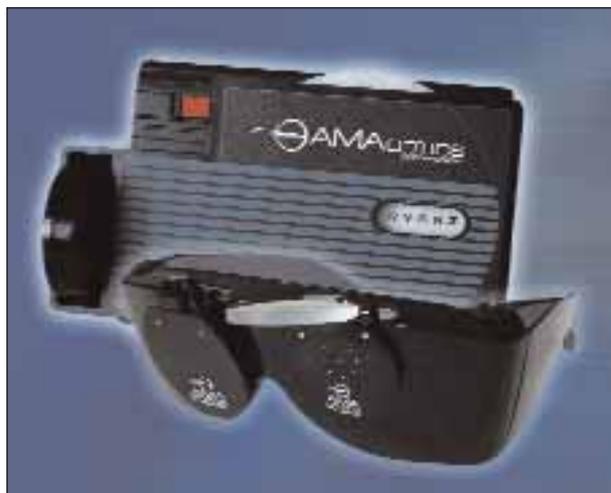


Figure 2. The Retinal Acuity Meter is portable and lightweight, and it allows testing in less than 1 minute.

nal or optic nerve pathology that inherently diminishes contrast sensitivity may not be suitable candidates for multifocal IOLs, which may decrease contrast sensitivity compared with aspheric monofocal IOLs. This loss of contrast may relate to the splitting of light energy between multiple foci or the loss of light energy to higher diffractive orders. The effect could be particularly troublesome in patients whose optic nerve or macular function is already compromised. In addition, there has been a report of a retinal surgeon having impaired stereoscopic visualization intraoperatively when performing an epiretinal membrane peeling in a patient who had an acrylic multifocal IOL, despite a clear view of the macula.¹ Furthermore, there have been earlier reports of difficulty in performing vitreoretinal surgery in patients with an Array silicone multifocal IOL.² Implanting an accommodating lens would raise fewer concerns about decreased contrast sensitivity in eyes with retinal pathology that might require vitreous surgery. Some fogging under air or silicone oil with silicone IOLs, however, could affect visualization intraoperatively or result in residual oil's beading against the posterior aspect of the IOL after the oil's removal, if there is a patent capsulotomy.

There is no substitute for a detailed history and retinal examination in these patients. In addition, surgeons need to assess the patient's macula and optic nerve with a 90.00 D or 78.00 D lens to identify macular

pathology or optic neuropathy. Surgeons should also examine the peripheral retina, especially in high myopes who are at higher risk for retinal detachment. Although optical coherence tomography and fluorescein angiography as well as a referral to a retinal specialist may be appropriate for patients in whom pathology is identified, the anatomic appearance of the lesion often does not directly correspond with retinal function. For example, a gossamer-thin epiretinal membrane seen on ophthalmoscopy, confirmed by optical coherence tomography, with no fluorescein findings, could still have a negative impact on visual function postoperatively in a patient desiring a multifocal or accommodating IOL. A patient with what appears to be significant dry macular degeneration, however, might have greater visual potential than the surgeon anticipates based upon appearance alone.

METHODS OF ASSESSMENT

Several tests have been developed to predict postoperative visual acuity. Pinhole testing, although useful in practice by placing the eye at an almost universal depth of focus and reducing optical aberrations, has a disadvantage of reduced light because its small aperture limits retinal illumination.

Clinical interferometry is based upon interference patterns forming a series of black and white lines on the retina. The distance between these lines is used to define potential visual acuity. Unfortunately, there is a tendency to overestimate retinal potential with this method in eyes with concurrent cataract and maculopathy, because the large grating targets (in contrast to Snellen letters) can be effectively discerned by portions of the retina outside the macula.

The Potential Acuity Meter (Marco Ophthalmics,

Jacksonville, FL) projects a Snellen chart in a small beam of light through the less opaque area of the lens onto the retina. It is more effective than a pinhole or interferometer due to its enhanced retinal illumination and the use of Snellen letters, respectively. The meter's use is often cumbersome, however, because the doctor or a technician must align the letters and adjust the position of the patient's head. Additionally, the predictability of the Potential Acuity Meter has been erratic in cases of dense media opacity, maculopathy, and/or advanced glaucoma.²⁻⁶

In my practice, we routinely utilize the Retinal Acuity Meter (AMA Optics, Inc., Miami, FL) to help us



Figure 3. The panoramic pinhole option clips onto the Retinal Acuity Meter trial frame and has a series of seven viewing apertures.

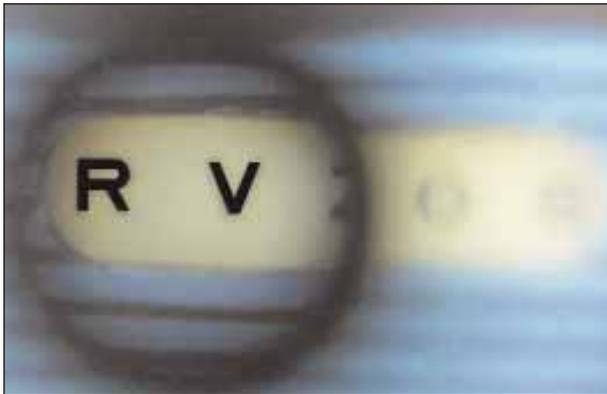


Figure 4. The panoramic pinhole feature allows the patient to appreciate the potential visual improvement that may result from clearing the optical media.

assess patients' potential visual function (Figure 2). The unit also helps us to identify patients with comorbid retinal or optic nerve pathology that may not be detected by history and inspection alone, particularly in eyes with cloudy media. The Retinal Acuity Meter consists of an illuminated reading card and a 16-inch retractable tape measure. The latter ensures that the card is held exactly 16 inches from the patient so that the target letters will subtend the appropriate number of degrees of arc on the retina. The patient wears a trial frame over his distance correction or glasses, which allows the insertion of an opaque disc with eight pinholes, and a flip-down +2.50 D lens available for a reading add. The illuminated viewing window in the device displays single lines, and the target can be rotated to present optotypes corresponding to between 20/200 and 20/20 visual acuity.

The effectiveness of the Retinal Acuity Meter is based on three optical principles: visual angle calibrated to testing at a fixed reading distance, bright illumination (16 times the brightness of a standard reading card), and pinhole effect, which decreases ocular aberrations and enlarges the depth of field by obscuring unfocused rays of light. An evaluation of the image through all eight pinholes allows patients to select their optimal visual axis. They then align the image, pinhole, least cloudy media pathway, and best retinal region, thereby optimizing the assessment of potential retinal acuity. In contrast, with the Potential Acuity Meter, the examiner, rather than the patient, aligns the image and chooses the ocular axis that appears to allow the target beam to project through the least dense lenticular opacity. A number of studies demonstrate

greater predictive accuracy with the Retinal Acuity Meter compared with the Potential Acuity Meter.⁵⁻⁷ The predictability of these tests, however, may vary with specific forms of macular comorbidity.

Although no test of retinal function, including the Retinal Acuity Meter, has 100% specificity and sensitivity, in my practice, however, my colleagues and I have favored this device over others for reasons in addition to its accuracy. First, the test is easy to administer for both the patient and the technician. Unlike with the Potential Acuity Meter, chin-rest-eye alignment is not necessary, making it easier for patients with neck or back disease to undergo testing. The patient's head does not move up and down on the chinrest when he vocalizes responses, movement that could affect the test's accuracy. Another plus, the Retinal Acuity Meter is small, lightweight, and battery operated with a calibrated light source. It fits inside a lab coat pocket, so it is readily available for use in any room or examining lane without special setup. The test can be performed in less than 1 minute. A new accessory to the Retinal Acuity Meter is a panoramic pinhole (Figure 3), which gives the patient a simultaneous visual comparison of his currently obscured vision and his potential vision (Figure 4). This effect is produced by views inside and outside the pinholes when a cataract or other opacity is present in the eye.³



Figure 5. The Brightness Acuity Meter works in conjunction with the Retinal Acuity Meter to assess the functional impact of glare.

IN SUMMARY

Overall, I have found the Retinal Acuity Meter to be a practical, affordable, and accurate tool for rapidly assessing retinal function and potential postoperative visual performance in patients with 20/100 or better preoperative visual acuity. The unit is not reliable for patients with a BSCVA of 20/200 or worse. The meter permits a detailed evaluation of macular function to correlate with structural observations, provides important information that assists in surgical counseling, and allows me to deliver better care to my cataract patients. If used routinely in patients with early-onset cataract, a sudden decrease in the Retinal Acuity Meter's measurement may portend the onset of an unrelated comorbid disease and a need for further evaluation.

A Brightness Acuity Meter (AMA Optics, Inc.) is lightweight portable. The device can perform glare testing in conjunction with the Retinal Acuity Meter modified with a calibrated light filter to reduce the reading window to 85 cd/m² (Figure 5). The Brightness Acuity Meter is a handheld device for measuring the effects of glare on visual acuity. As stipulated by current Medicare guidelines, one indication for

cataract extraction includes the utilization of a glare component that reduces visual acuity to less than 20/40. The Brightness Acuity Meter also serves as a light source for the macular photostress test, which can detect subtle forms of macular dysfunction.

AMA Optics is also developing a unit that utilizes contrast sensitivity testing gradients. The Contrast Acuity Meter is a portable, back-illuminated, contrast sensitivity measurement system designed to evaluate visual function relative to changes in contrast under mesopic and photopic conditions with and without glare. The unit follows the model of the Regan chart optotype with contrast ratios from 96% to 4%, and it can be used with the Brightness Acuity Meter or another calibrated source of glare. ■

Jay S. Pepose, MD, PhD, is a professor of clinical ophthalmology and visual sciences, Washington University School of Medicine, and director, Pepose Vision Institute, St. Louis. He is a consultant to Bausch & Lomb and Visiogen but acknowledged no financial interest in any of the products or companies mentioned herein. Dr. Pepose may be reached at (636) 728-0111; jpepose@peposevision.com.



1. Luttrull JK, Dougherty PJ. Acrylic multifocal IOLs. *J Refract Surg.* 2007;23:329-330.
2. Mainster MA, Reichel E, Warren KA, Harrington PC. Ophthalmoscopy and vitreoretinal surgery in patients with an Array refractive multifocal lens implant. *Ophthalmic Surg Lasers.* 2002;33:74-76.
3. Asbell PA, Chiang B, Amin A, Podos SM. Retinal acuity evaluation with the Potential Acuity Meter in glaucoma patients. *Ophthalmology.* 1985;92:765-777.
4. Le Sage C, Bazalgette C, Arnaud B, Schmitt-Bernard C. Accuracy of IRAS GT interferometer and potential acuity meter prediction of visual acuity after phacoemulsification. *J Cataract Refract Surg.* 2002;28:131-138.
5. Chang MA, Airiani S, Miele D, Braunstein RE. A comparison of the Potential Acuity Meter (PAM) and the Illuminated Near Card (INC) in patients undergoing phacoemulsification. *Eye.* 2006;20:1345-1350.
6. Vianya-Estopa M, Douthwaite WA, Noble BA, Elliott DB. Capabilities of potential vision test measurements. Clinical evaluation in the presence of cataract or macular disease. *J Cataract Refract Surg.* 2006;32:111-160.
7. Hofeldt AJ, Weiss MJ. Illuminated near card assessment of potential acuity in eyes with cataract. *Ophthalmology.* 1998;105:1531-1536.