

REVIEW

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Practical methods of vision-potential testing

PREMIUM intraocular lenses (IOLs) are technologically advanced IOLs that correct presbyopia (multifocal and accommodative) and astigmatism (toric), or provide sharper vision especially under low-light or nighttime conditions (aspheric). These are currently utilized for patients undergoing cataract surgery or refractive-lens exchange and have raised expectations for postoperative visual outcomes. While these IOLs potentially confer improved visual capability, they are more expensive. Because ophthalmologists are pressured to deliver consistently excellent visual outcomes after surgery, the ability to evaluate retinal visual acuity and predict postoperative vision has become an essential tool for setting patient expectations and identifying which patients may benefit from these technologies. Several factors such as poor preoperative visual acuity, cataract type or severity, and coexisting posterior-segment disease may affect the accuracy of predictive tests, and these should be considered when interpreting predicted vision, especially in preoperative counseling of patients.¹ We review here 3 commonly used and practical methods of prognosticating visual outcomes after cataract surgery.

I. PINHOLE TEST

There are two major categories of blurred vision: 1) Refractive or optical media problems that improve with glasses or by removal of media opacities; and 2) Nonoptical problems due to disease processes affecting the retina or optic nerve. A quick way to differentiate between the two is by performing the pinhole test (PH).

Procedure

Create a pinhole approximately 2 mm in diameter by perforating a card or piece of paper with a pen tip. Using proper distance correction, check one eye at a time by occluding the other eye. Instruct the patient to read the characters on a wall-mounted reading chart (eg. Snellen) or projected chart. Record the distance best-corrected visual acuity (BCVA). Then look at the same object through the pinhole and record the PH BCVA. If the BCVA improves using the PH, a refractive error or optical media problem (eg. cataract or vitreous hemorrhage) is present.

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Applications

In a prospective study of 64 eyes with mild to moderate cataract that underwent uneventful phacoemulsification, the PH correctly predicted BCVA in 5% of eyes. The PH accurately predicted BCVA within 1, 2, and 3 lines in 23%, 40%, and 54% of eyes respectively. The accuracy of PH test was found to decrease in eyes with poorer preoperative visual acuity or denser cataracts.²

PH vision is a quick method to assess best-corrected vision. By looking through a pinhole, the refractive errors of the peripheral cornea and crystalline lens of the eye are significantly reduced or eliminated, and PH acuity simulates that with proper glasses in place or clearing of media opacity. PH test may be used to predict BCVA after refractive surgery, cataract extraction, vitrectomy for hemorrhage, or asteroid hyalosis.

II. POTENTIAL-ACUITY METER

The Guyton-Minkowski Potential-Acuity Meter (PAM) measures retinal visual acuity behind a cataract or other media opacity. First introduced in 1983, the PAM has mainly been used to estimate visual outcomes after cataract surgery. The PAM projects a Snellen eye chart via a narrow beam of light, which converges to an aerial aperture or opening measuring 0.1 mm. This opening is placed onto less-dense areas or "windows" within the cataract allowing the eye chart to be focused onto the retina with minimal cataract-induced light scattering. Because the PAM test uses a smaller aperture than the pinhole (1 mm), it is more accurate in measuring retinal acuity and in providing an estimate of postsurgical visual results.³

Procedure

PAM testing is performed in a dimly lighted room. Other eye charts are turned off to avoid confusion. The PAM is mounted on a slitlamp set to the lowest magnification and whose illumination is turned off to avoid glare. Pupil dilation is preferable because more "windows" are made available for the PAM light beam to pass through. Amblyopic patients may do better after patching of the good eye. The eye should not be exposed to bright lights just prior to performing the test. The operator then sets the dioptic setting to the approximate spherical equivalent of the eye.

The operator explains to the patient that a light will appear and that letters or numbers will be visible; the clarity of the characters may change during the test. The patient is instructed to avoid head movement as this will displace the light beam and delay the procedure. The patient should report what characters are visible through clenched teeth, to minimize head movement. The basic technique is to focus the beam onto the patient's retina through the cataract. The patient is encouraged to read

aloud the lines of the chart until no other smaller, legible lines are encountered. The process is repeated until the examiner is confident that the patient cannot read any finer lines. If the patient correctly reads any 3 characters in a certain line, that level of visual acuity is established. The PAM result is the smallest line where the patient reads 3 characters even if he loses sight of it in subsequent retesting. The light beam should be repositioned in order to try other "windows" to enable the patient to see additional finer lines. The test takes 5 to 10 minutes per eye.

PAM is mostly used for patients about to undergo cataract surgery, but it may also be used for other ocular media problems: large refractive errors, corneal/vitreous opacities, partial hyphema, IOL deposits, posterior capsular opacities, and asteroid hyalosis. In general, if any retinal detail is clinically visible, there is an adequate window for PAM testing. This is possible because the PAM light beam is only 0.1 mm in diameter, which is smaller than the size of the pupil needed to see the retina. For opaque corneas, mature cataracts, thick pupillary membranes, dense vitreous hemorrhage, and severe optic-nerve or retinal disease, the patient may report that the PAM light is not visible. Nonocular conditions that make PAM testing difficult to impossible include poor patient posture or mental status, literacy, nystagmus, and patient fatigue.

Applications

In their original report, Minkowski-Guyton noted that among cataractous eyes having best preoperative visual acuity of 20/200+, the postoperative visual acuity was correctly predicted to within 3 lines in 100% of cases and to within two lines in 91% of cases. PAM correctly predicted postoperative visual outcomes of 20/40+ in 95% of cases. Most studies report that PAM correctly predicts visual acuity to within 2 lines in approximately 80 to 90% of patients. PAM testing tends to underestimate potential acuity so postsurgical results are usually better than predicted. The accuracy of the PAM test decreases when the cataract is denser and when preoperative visual acuity is poorer.²⁻⁵ Patients with these characteristics should not be excluded from cataract surgery on the basis of poor PAM results. In our practice, PAM results are a basis for IOL selection. Patients with poor PAM results are excluded from receiving multifocal IOLs since good retinal acuity is a requisite for obtaining good results with these expensive IOLs.

PAM is used to test retinal acuity in eyes with other media problems, for rapid potential vision screening in patients with vitreoretinal diseases, microphthalmia, and large or irregular refractive errors. PAM testing is also used to identify which patients with posterior capsular opacities

may benefit from YAG capsulotomy.⁶ When both eyes have cataracts and similar preoperative visual acuities, PAM can be used to select which eye will first undergo cataract surgery.

PAM testing is used to identify patients with coexisting ocular diseases (e.g. retinal or nerve pathology) who may benefit from cataract surgery. A few studies have reported that PAM is potentially useful in predicting postsurgical results in patients with cataracts and coexisting posterior-segment disease such as macular degeneration and macular hole. There is a tendency for PAM to generate false positive (overestimated) results in patients with macular degeneration. The combination of PAM and automated visual-field testing was useful in predicting outcomes following combined cataract surgery and trabeculectomy.

The clinical reliability of PAM in predicting treatment results for noncataractous conditions has not been established. PAM testing is not consistently reliable in predicting visual results after macular-hole surgery. An intriguing but limited case series has suggested that PAM may be useful for predicting improvement after treatment for cystoid macular edema by identifying intact but dysfunctional photoreceptors.⁸

III. POTENTIAL-ACUITY PINHOLE

Potential-Acuity Pinhole (PAP) test is easy to perform and requires only instruments available in any examination lane. It has been shown to approximate the results of PAM.

Procedure

The patient is given reading correction on a trial lens or vision tester. The eye not tested is occluded while the tested eye is allowed to see through a pinhole and read letters on an illuminated pocket near vision chart held at a standard 14 inches away from the eye. The distance equivalent is recorded as the result.

Applications

A prospective trial compared the reliability of PAP to PAM. The PAP test predicted visual outcomes within 2 lines in 100%, 100%, and 56% of eyes with preoperative BCVA of 20/50 and better (group 1), 20/60 to 20/100 (group II), and 20/200 and worse (group III) respectively. The PAM correctly predicted visual outcomes within 2 lines for the same groups in 42%, 47%, and 0% respectively. Mean lines of inaccuracy of PAP predictions were 0.83, 1.11, and 3.50 lines for groups I, II, and III.

Mean lines of inaccuracy for PAM predictions were 2.50, 2.68, and 6.22 lines for the same groups. Differences in lines of prediction between PAM and PAP were 1.67 ($p = 0.004$) for group I, 1.58 ($p = 0.0002$) for group II, and 2.72 lines ($p = 0.0001$) for group III.

There was no statistically significant correlation between PAP predictions and preoperative myopic spherical equivalent. The study concluded that the PAP test is a simple, inexpensive, and relatively reliable method to estimate visual outcome after uncomplicated cataract surgery in eyes without comorbidity. PAP was less accurate in patients with preoperative BCVA worse than 20/200.⁷

SUMMARY

The advent of premium IOLs has intensified the need to do predictive testing for eyes undergoing cataract surgery. Pinhole testing is inexpensive and readily available; however, it is not as reliable for dense cataracts nor as accurate as PAM. The PAP is a refinement of the pinhole test with improved accuracy but requires more effort and time. The PAM apparatus is fairly low cost, easily sourced, more accurate, and easy to incorporate into a practice. Other systems such as laser interferometry are more expensive and difficult to source.

Current high patient expectations and the increasing use of costly, premium IOLs have clearly established a need for a predictive screening tool before cataract surgery or other procedures such as YAG capsulotomy. PAM is an imperfect but reasonably reliable and easily available method for predictive testing and has a definite place in current clinical practice.

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