Recent advances in automated perimetry and optical coherence tomography have demonstrated strong clinicopathologic associations between scotomata and nerve fiber layer thinning. This gives eye care providers more confidence when diagnosing glaucoma and monitoring the efficacy of treatment. Verifying the presence and extent of glaucoma is no longer a major problem. Identifying which patients receiving therapy remain at risk of disease progression, however, has continued to be a guessing game.

Many patients with seemingly adequate IOP control in the clinic continue to lose function. Some of them may not adhere to prescribed medical therapy, and others may have a more IOP-independent multifactorial disease etiology or even intermittent angle closure. Whatever the source of the problem for a given patient, even if visual field testing were repeated at 4-month intervals, it would be expected to take 2 years to verify chronic disease progression using the latest visual field progression software. That is a long time to wait to make appropriate adjustments in treatment interval and intensity. A dynamic functional test that provided prognostic information on the basis of a single visit might help avoid needless morbidity and reduce costs considerably.

**VISUAL EVOKED POTENTIAL AND ELECTRORETINOGRAPHY**

The literature on the potential diagnostic and prognostic utility of visual evoked potential (VEP) and electroretinography (ERG) is extensive. VEP is an objective measure of visual function that assesses the electrical activity of the cerebral cortex via electrodes placed on the scalp while the subject views standardized visual stimuli. The amplitude and latency of the VEP waveforms are affected by various pathologic conditions of the visual pathway, including glaucoma.

Recent technological developments have made VEP and ERG assessment faster and more patient friendly through the automated interpretation of test results and a reduction in the cost of the instrumentation. One example is short-duration transient VEP (SD-tVEP), which combines synchronized signal acquisition with a postprocessing technique to decrease subjectivity in waveform assessment (Figures 1 and 2).

**RESEARCH**

**Methodology**

My colleagues and I recently undertook to determine the association of SD-tVEP amplitude and latency abnormality scores (Diopsys NOVA-LX; Diopsys) with perimetric staging and to explore potential single-visit SD-tVEP prognostic utility using 30-2 visual field progression data (Humphrey Field Analyzer [HFA]; Carl Zeiss Meditec). This cross-sectional study was performed in our glaucoma...
subspecialty clinic. It involved a broad array of adult patients already receiving medical, laser, and/or surgical therapy for their glaucoma, all with good IOP control on the day of a single SD-tVEP evaluation. Testing was performed by qualified ophthalmic technicians who regularly perform visual field and optical coherence tomography testing. None had any prior experience with electrophysiology.

The proportion of eyes designated as suspicious or abnormal by the Diopsys Nova-LX scoring algorithm was determined for patients with differing perimetric disease severity based on their latest HFA 30-2 visual field (mild, mean deviation (MD) > -6 dB; moderate, -6 to -12 dB; severe, MD < -12 dB). We compared latency failure with HFA Guided Progression Analysis acquired over the preceding 4 to 7 years to determine whether a single VEP test might help to identify eyes at increased risk of progressive visual field loss. A highly significant correlation was observed between high-contrast SD-tVEP latency and visual field loss category ($P < .001$; Figure 3).

**Results**

We analyzed a total of 133 eyes of 84 patients (mean age, 68 years). SD-tVEP latency increased linearly with the severity of visual field loss under 85% (high) contrast testing conditions ($P = .001$). One-third of the eyes showed rapid progression ($\geq 0.7$ dB/y). Based on the progression analysis of more than 1,200 visual fields (a mean of more than 12 visual fields per eye [range, 5-18 fields]), nearly three-quarters (73%) of eyes demonstrating rapid disease progression showed a VEP latency abnormality on the
Diopsys Nova-LX, whereas fewer than half (47%) of the more visually stable remaining eyes showed any latency abnormality. Across the entire study population, the mean progression rate for eyes with a latency abnormality was -0.87 ±0.3 dB/y versus a rate of -0.32 ±0.4 dB/y for those with normal latency. These data (W.E.S., unpublished data, 2015) suggest that SD-tVEP may afford incremental value as an elective, single-visit, prognostic test for glaucomatous progression.

**PRACTICAL IMPLICATIONS**

What is the clinical value of this kind of incremental informational yield? The question is probably best considered in the context of disc hemorrhage, the most widely studied and best-established single-visit clinical prognostic indicator predictive of visual field loss. De Moraes et al recently confirmed disc hemorrhage as “the single most significant predictor of visual field progression.” In a recent 8-year follow-up, Medeiros et al determined that the relative rates of visual field progression for eyes with and without disc hemorrhages were -0.88%/y versus -0.38%/y, respectively, a progression ratio remarkably similar to what we found using SD-tVEP latency abnormality. There is one very important difference: disc hemorrhages in the study by Medeiros et al arose spontaneously in only 2% of glaucomatous eyes per year, whereas almost any glaucoma patient may undergo testing with the Nova-LX at any time. This is merely an encouraging start. There is plenty of room for improvement in these ratios as more information is incorporated into Diopsys’ comparative database for diseased and normal eyes.

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