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Frequency Doubling Technology Perimetry 2 (24-2) in the Evaluation of Homonymous Hemianopias

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Purpose

Frequency doubling technology 2 (FDT) perimetry is a method of visual field testing that uses smaller FDT stimuli (5°) with an approximately six-degree spaced grid of the central 27°. FDT 1 with its 17 separate 10° stimuli is an effective screening method for glaucomatous field loss but has an issue with stimulus detection in the hemianopic field by the uninvolved hemifield. The purpose of this study was to compare FDT2 to conventional automated perimetry (CAP) in the detection of homonymous hemianopias.

Methods

FDT 2 (FDT2 24-2, 55 separate 5° stimuli) and CAP (SITA Standard 24-2, 54 separate size III, 0.43° stimuli) were performed on 25 patients with homonymous hemianopias. The total deviation and pattern deviation probability plots were compared by inspection of probability plots with respect to similarity (good, fair, poor). We also evaluated the extent (equivalent, FDT2, CAP) of the defect by two visual field readers; at least 25% more abnormal test locations needed to be present for one test to have greater extent. A preliminary database of 81 normals was used to generate the probability plots.

Results

For the total deviation probability plots, the similarity of the defect shown on FDT and CAP was judged to be good in 54% of cases, fair in 33% of cases, and poor in 13% of cases; the extent of the defect on FDT and CAP was equal in 58% of cases, more extensive on CAP in 33% and more extensive on FDT in 8% of cases. For the pattern deviation probability plots, the similarity of the defect shown on FDT and CAP was judged to be good in 63% of cases, fair in 33% of cases, and poor in 4% of cases; the extent of the defect on FDT and CAP was equal in 67% of cases, more extensive on CAP in 25% and more extensive on FDT in 8% of cases. There were 5 instances of some stimulus detection by the uninvolved hemifield along the vertical midline.

Conclusions

tes well with CAP based upon similarity of shape and extent of visual field defects due to homonymous hemianopia. Stimulus detection in the involved hemifield along the vertical meridian is present in 1/5 of cases but is less prominent than with FDT 1.

Frequency Doubling Perimetry for Optic Nerve and Chiasmal Neuro-Ophthalmic Disorders

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Purpose
When a low spatial frequency sinusoidal grating undergoes counterphase flicker at a high temporal frequency, the spatial frequency of the grating is perceived as doubled. Frequency Doubling Technology 2 (FDT2) is a promising new modality for the evaluation of patients with neuro-ophthalmic disorders. The FDT2 24-2 program has 55 test points as compared to 17 for the previous FDT C-20 program. The purpose of this study was to compare the FDT2 perimeter with the Humphrey (HFA II) perimeter for optic nerve and chiasmal neuro-ophthalmic disorders.

Methods
Four readers compared correlation between the FDT2 24-2 and HFA II SITA Standard 24-2 test patterns using 126 abnormal visual fields. Our analysis included patients with optic nerve and chiasmal neuro-ophthalmic disorders. The readers assigned separate correlations (Good, Fair, or Poor) to each eye using preliminary Total and Pattern Deviation probability plots for the FDT2 and standard Total and Pattern Deviation probability plots for the HFA II. The readers also ranked perimeters by the depth and extent of visual field loss (Equivalent, FDT2, or Humphrey).

Results
For the Total Deviation probability plots, 66/126 (52%) had Good correlation, 35/126 (28%) had Fair correlation, and 25/126 (20%) had Poor correlation. For the Pattern Deviation probability plots, 44/126 (35%) had Good correlation, 47/126 (37%) had Fair correlation, and 35/126 (28%) had Poor correlation. The extent of the defect as seen on Total Deviation probability plots was equal in 58/126 (46%) of cases, more extensive with FDT2 in 36/126 (29%), and more extensive with HFA II in 32/126 (25%). The extent of the defect as seen on Pattern Deviation probability plots was equal in 38/126 (30%) of cases, more extensive with FDT2 in 47/126 (37%), and more extensive with HFA II in 41/126 (33%).

Conclusions
The new FDT2 24-2 testing strategy provides a screening and quantitative visual field testing parameter for optic nerve and chiasmal neuro-ophthalmic disorders that correlates reasonably well with the HFA II SITA Standard 24-2 program. However, there are some clear differences in regard to correlation, extent, and depth of the defect. Further evaluation will be necessary to evaluate the differences between the programs for patients with optic nerve and chiasmal disorders.

Normal Aging Effects for Two Forms of Frequency Doubling Technology (FDT) Perimetry Using a 24-2 Stimulus Presentation Pattern

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Purpose

To compare normal aging effects using two different forms of Frequency Doubling Technology (FDT) perimetry, with smaller targets and a 24-2 stimulus pattern. One method uses the Quadravision test procedure (QFDT), while the other is a prototype being developed for commercial purposes (FDT2). The two procedures incorporate different stimulus backgrounds, stimulus sizes, target locations and threshold test strategies.

Methods

Normal observers had to be between the ages of 18 and 85, have a normal anterior segment and posterior pole examination, normal visual fields for standard automated perimetry (SAP), no prior history of ocular disease or surgery, no history of systemic disease that could affect vision, visual acuity of better than 20/40, refractive errors of less than 5 D and less than 2 D of cylinder and could not be taking any medications known to affect vision OU. QFDT uses a 50 cd/m2 background luminance, a Modified Binary Search [MOBS] test procedure, and 4 degree diameter targets and a 24-2 stimulus presentation pattern. FDT 2 uses a 100 cd/m2 background, a ZEST (maximum liklihood) test strategy, 5 degree diameter targets and a pattern that is slightly different from a 24-2 stimulus presentation pattern. Both tests utilize a sinusoidal spatial frequency of 0.5 cycles/ degree and a counterphase flicker rate of 18 Hz. One hundred normal observers were tested with QFDT, and 101 normal subjects were tested with FDT2.

Results

For stimuli within 15 degrees radius, both QFDT and FDT2 show linear effects of aging (approximately 0.6 dB loss per decade) that are similar to those obtained for the commercial version of FDT incorporating 17 or 19 large targets. Outside of 15 degrees, QFDT shows a larger aging effect (about 1.0 to 1.2 dB per decade) than FDT 2 (about 0.8 dB per decade).

Conclusions

Aging effects (0.6 dB per decade) for the central visual field of both 24-2 FDT procedures were similar to earlier findings for the original FDT device. Outside 15 degrees, aging effects were greater for QFDT than for FDT 2. Differences in stimulus size and test duration account for the majority of these variations in aging effects for QFDT and FDT 2.

Within-test variability of frequency-doubling perimetry using a 24-2 test pattern

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Discoveries in Sight, Devers Eye Institute, Portland, Oregon, USA. paul.spry@ubht.swest.nhs.uk. Received August 28, 2001 accepted after revision Febr.25, 2002. This project was supported by NEI Grant #EY-03424 (to C.A.J.)

Purpose

To evaluate patient-response (within-test) variability for targets of the smaller frequency-doubling technology perimetry test that employs a 24-2 stimulus-presentation pattern.

Methods

Patient-response variability was examined using the method of constant stimuli for standard (10 degrees) and small (4 degrees) customized frequency-doubling technology perimetry stimuli presented on a CRT screen. Small stimuli were designed for use in a 24-2 test pattern. Matched test locations were examined in 24 subjects (8 normal, 8 in whom glaucoma was suspected, and 8 glaucoma patients). Threshold sensitivity (in decibels for the 50% detection level) and variability (interquartile range in decibels) were obtained from frequency-of-seeing curves derived from data fitting with cumulative Gaussian functions. Groups were compared using a two-way ANOVA.

Results

Thresholds obtained using standard and small stimuli were highly correlated ($R = 0.94$, $P < 0.001$, Pearson correlation), although smaller targets systematically estimated sensitivity to be 2.0 dB (95% CI, 1.7-2.4 dB) lower than standard targets. No significant difference in patient-response variability was observed between standard and small targets ($P = 0.067$), although both target sizes demonstrated small but significant increases in variability with reduced sensitivity. Mean (SD) patient-response variability for the normal, suspect, and glaucoma groups was 1.0 (0.6), 0.9 (0.4), and 1.8 (1.4) dB for standard-sized stimuli and 1.1 (0.8), 1.5 (1.2), and 2.0 (0.9) dB for small stimuli.

Conclusions

Small (4 degrees) frequency-doubling technology perimetry targets have variability characteristics that are not statistically significantly different from those observed for standard-sized (10 degrees) stimuli. Reduction in frequency-doubling technology perimetry stimulus size necessary to produce 24-2 test resolution is unlikely to affect test repeatability. Smaller, more numerous stimuli may offer clinical advantages both in terms of detecting small defects and identifying progressive loss.

Performance of Efficient Test Procedures for Frequency-Doubling Technology Perimetry in Normal and Glaucomatous Eyes

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Purpose
To validate the clinical performance of two new efficient threshold-estimation procedures for frequency-doubling technology (FDT) perimetry in both visually normal individuals and patients with glaucomatous visual field loss.

Methods
Forty-one normal subjects (mean age, 48.3 ± 11.6 years) and 50 patients with glaucomatous visual field loss (mean age, 72.7 ± 10.0 years) were tested. Some of these participants were retested within a 3-month period. FDT perimetry was performed on a color monitor driven by a visual-stimulus–generating video board, with stimulus parameters designed to closely mimic those of the commercial FDT test. Visual field sensitivity was measured using three procedures: a modified binary search (MOBS) identical with the one used in the commercial FDT device, a rapid efficient binary search (REBS), and a procedure the uses Bayesian methods (zippy estimation of sequential testing; ZEST). The selection of optimum parameters for REBS and ZEST were based on results from previous simulations.

Results
Both ZEST and REBS were 40% to 50% faster than MOBS. All three methods produced similar visual field sensitivity measures, with 95% of the differences occurring between ±2 dB for normal subjects and ±3 dB for glaucoma patients. Test–retest performance was similar for all three procedures.

Conclusions
The test time for full-threshold FDT perimetry can be approximately halved, by using either the ZEST or REBS procedure, without affecting the accuracy or reliability of the measurements. These findings in normal subjects and patients with glaucoma provide clinical confirmation of our previous investigations of these test strategies that use computer simulation.

Frequency doubling technology perimetry using a 24—2 stimulus presentation pattern

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Optom Vis Sci. 1999 Aug ;76(8) : 571-81
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Purpose
To assess whether smaller targets and a 24-2 stimulus presentation pattern would improve the ability of frequency doubling technology (FDT) perimetry to detect and characterize early glaucomatous visual field loss.

Methods
One hundred normal subjects between the ages of 20 and 85 participated in this study. In addition, 53 patients who either had early glaucomatous visual field loss (n = 23) or were high-risk glaucoma suspects with normal conventional visual fields (n = 30) were evaluated with the commercial version of FDT perimetry (full threshold test) with 17 stimuli (four 10 degrees diameter square targets per quadrant and a central 5 degrees circular target) and a custom version of FDT perimetry using 54 stimuli (4 degrees targets with 6 degrees grid spacing) arranged in a 24-2 stimulus presentation pattern.

Results
The custom FDT test using a 24-2 stimulus presentation pattern had a similar dynamic range, and demonstrated normal aging characteristics and test-retest reliability that were similar to the commercial version of FDT perimetry using 17 larger stimuli. Both FDT tests showed an age-related sensitivity reduction of approximately 0.6 dB per decade, and exhibited an average test-retest reliability of 1 to 1.5 dB. The custom 24-2 FDT perimetry test had a greater variation of sensitivity with eccentricity than the commercial version of FDT perimetry that was probably related to the difference in stimulus size. The custom 24-2 FDT perimetry test had a greater percentage of abnormal test locations than the commercial FDT test for both early glaucomas and high-risk glaucoma suspects.

Conclusions
FDT perimetry can be performed with smaller targets using a presentation pattern that is similar to conventional automated perimetry. In comparison to the commercially available 17 target display, the 24-2 stimulus pattern appears to have modestly higher sensitivity for detection of early glaucomatous loss and provides better characterization of the pattern of visual field loss, but the test takes approximately twice as long.

Development of Efficient Threshold Strategies for Frequency Doubling Technology Perimetry Using Computer

Simulation Andrew Turpin[1], Allison M. McKendrick[1], Chris A. Johnson[1] and Algis J. Vingrys[2]

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Purpose
To develop new test procedures for frequency-doubling technology (FDT) perimetry that improve performance beyond those currently used.

Methods
Two novel threshold estimation procedures were evaluated: a rapid, efficient binary search technique (REBS) and a maximum-likelihood estimation (ZEST) procedure. A computerized visual field simulation model was developed to determine the accuracy and efficiency of these procedures. This model was constructed using previously derived characteristics of FDT perimetry from both normal observers (n = 506) and those with glaucomatous visual field loss (n = 352). The computer simulation program was used to determine the best parameters for the two new procedures and the effect of variability and response errors on algorithm performance. Comparisons were made to the performance of the modified binary search (MOBS) procedure used in the current commercial implementation of the FDT perimeter.

Results
Both the optimized REBS and ZEST procedures approximately halved the time required for FDT threshold testing without loss of accuracy or reproducibility.

Conclusions
With suitable parameter choices, comparable performance was achieved using either ZEST or REBS. Simulation results indicate that accurate thresholds can be measured with an optimized ZEST or REBS procedure in approximately half the time required by traditional estimation methods.

Variability Components of Standard Automated Perimetry and Frequency-Doubling Technology Perimetry

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(Investigative Ophthalmology and Visual Science. 2001;42:1404-1410.)

From Discoveries in Sight, Devers Eye Institute, Portland, Oregon.

Purpose
To evaluate and compare intra- and intertest variability components for both standard automated perimetry (SAP) and frequency-doubling technology (***FDT***) perimetry in a small group of normal individuals and patients with glaucoma.

Methods
The method of constant stimuli (MOCS) was used to examine matched test locations with both SAP and ***FDT*** perimetry stimuli in a group of eight normal individuals and seven patients with glaucoma. Subjects were tested weekly at three predetermined visual field loci for 5 consecutive weeks. Frequency-of-seeing (FOS) curves were generated and used to quantify threshold sensitivity (50% seen on FOS, in decibels), intratest variability (FOS interquartile range, in decibels), and intertest variability (interquartile range of weekly repeated threshold determinations, in decibels).

Results
In patients with glaucoma, SAP intra- and intertest variabilities were found to increase with sensitivity reductions, as previously reported. ***FDT*** perimetry revealed that both intra- and intertest variability components did not appreciably change with reductions in sensitivity. With the measurement scales used in this investigation, both intra- and intertest variability components were significantly greater for SAP than for ***FDT*** perimetry ($P < 0.001$ and $P = 0.003$, respectively). Intratest variability exceeded intertest variability for both SAP ($P = 0.001$) and ***FDT*** perimetry ($P < 0.001$).

Conclusions
For both SAP and ***FDT*** perimetry, variability occurring within a single test session contributed more to total variability than between-session variability. When the measurement scales available on commercial instrumentation were used, ***FDT*** perimetry exhibited significantly less variability than SAP, especially within regions of visual field sensitivity loss. ***FDT*** perimetry therefore shows promise as an effective test for detecting progressive glaucomatous visual field loss, although prospective longitudinal validation is still required to determine sensitivity to change.

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