G1-TENDENCY-ORIENTED PERIMETRY
Introduction and comparison with G1-Standard Bracketing

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Abstract

Purpose: To compare the results of the new tendency-oriented perimetry (TOP) perimetric algorithm applied to the G1 point distribution with those from the well-known G1-Standard Bracketing strategy.

Methods: The G1-TOP program divides the G1 grid of 59 points into four sub-grids and adds ten extra points. The sub-grids are tested sequentially. Each point is tested only once. Each patient’s response is utilized to modify the tested point and the surrounding ones from the remaining sub-grids. For this task, their relative distances are taken into account. This study included 78 patients (106 eyes); mean age: 54.9 ± 17.2 years. The sample consisted of 47 eyes of patients with early glaucoma (MD <7dB), 21 with advanced glaucoma (MD ≥7dB), 12 eyes with visual fields originating from neurological disorders, 11 with abnormal fields from chorioretinal lesions, and 15 normal eyes. All subjects were examined consecutively with both programs using the Octopus 1-2-3 perimeter. The order of testing was interchangeable.

Results: The results of the G1 version of the TOP algorithm were similar to those obtained in a previous study with the TOP/32 version. Excellent correlation was found between the indices of the two examinations and with point-by-point analysis. G1-TOP produced, on average, a mean sensitivity 0.45dB higher than did G1-standard. Mean duration of the test for G1-TOP was 2:19 ± 0:36 minutes, while G1-standard took 11:15 ± 1:17 minutes (relation G1-TOP/G1-standard: 1/4.9, or a net reduction of 79.4%). Normal individuals had the same MD (TOP versus bracket: 0.2 ± 1.0 and 0.2 ± 1.5dB), while the loss of variance (LV) value was significantly smaller with TOP (TOP versus bracket: 4.3 ± 4.1 and 11.0 ± 13.0dB), (p<0.05).

Conclusions: The G1-TOP program produces very similar results to G1-standard in a small fraction of the time utilized by the traditional bracketing strategy.

Introduction

Tendency-oriented perimetry (TOP) strategy uses a mathematical algorithm of threshold search by consecutive approximations, examining four intermingled matrices1,2. The four matrices are examined sequentially. Each matrix is modified according to the responses of the patient and according to the rest of the matrices.
The test starts with the assumption that the patient’s threshold is equal to half its normal value (normal mean sensitivity). As the test progresses, it continuously establishes new assumptions, each time getting closer to the real threshold sensitivity level of the patient.

Extensive clinical experience with the point distribution of the G1 program has led us to adapt the new TOP algorithm to this irregular matrix. This study considers the results of using the G1-TOP algorithm.

**Material and methods**

The 59 points examined by program G1 were divided into four sub-grids, in consideration of the following requirements:
- similar number of points in each subgroup;
- homogeneous distribution of the points in the visual field area;
- symmetry regarding the 0-180 and 90-270 meridians.

Based on a preliminary analysis of the multiple possible combinations, the best way to fulfill the previous requirements was to add ten extra points to the G1 grid. Those

*Fig. 1. Points included in the four phases of program G1-TOP. Two extra points were added to phase III and eight to phase IV.*
G1-tendency-oriented perimetry

points were mainly utilized for intermediate linear interpolation calculations during the test, but were excluded at the end of the examination. Figure 1 shows the points included in each sub-grid of the resultant program.

Starting values for stimulus intensity and the steps or vectors applied to each of the sub-grids were similar to those utilized by program TOP-32. The first subgroup was tested with stimuli equivalent to half of the normal threshold sensitivity for an age-matched subject. Then, the direction or the vector (+ or −) applied to this value depended on the response of the patient (seen or not seen). The step had a magnitude equal to 4/16 of the normal sensitivity. The results were applied to that particular point as well as to the adjacent points from the other three sub-grids through linear interpolation. The resultant values of this operation were utilized as a starting point to examine the next sub-grid similarly. The magnitude of vectors applied to the remaining sub-grids decreased progressively, specifically utilizing 3/16, 2/16 and 1/16 of the normal sensitivity for each remaining sub-grid.

To apply the vectors from each examined group of points to the three adjacent groups of points not examined, a non-linear interpolation was carried out. To estimate the value of a vector to be applied to a point not tested, the program identified the three closest points to those examined in this phase (Fig. 2). Taking into account the magnitude of the vector to be applied to each one (V₁, V₂ and V₃) and the distances to the tested point (D₁, D₂ and D₃), a specific vector was calculated according to the following formula:

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\frac{(V₁/D₁) + (V₂/D₂) + (V₃/D₃))}{(1/D₁) + (1/D₂) + (1/D₃)}
\]

Fig. 2. Calculation of vector magnitude for a non-examined point based on the magnitude values and distances from the closest examined points.
The evaluation study examined 106 eyes of 78 patients with previous perimetric experience. Mean age was 54.9 ± 17.2 years. Exclusion criteria for subjects included poor reliability of automated perimetry testing, visual acuity worse than 20/40 (0.5), and presence of multiple ocular pathology.

The sample consisted of 15 normal eyes, 47 with early glaucoma (MD <7dB in conventional bracketing perimetry), 21 with advanced glaucoma (MD ≥7dB), 12 eyes with visual fields originating from neurological disorders, and 11 with abnormal fields from chorioretinal lesions. All subjects were examined consecutively with the G1-bracketing and G1-TOP programs using the Octopus 1-2-3 perimeter. A resting period of 30 minutes between the experimental and standard tests was allowed. The order of testing was interchangeable, starting with either the G1-TOP or G1-bracketing program.

Results

The results of the G1 version of the TOP algorithm were similar to those previously obtained with the ‘32-TOP’ version. Excellent correlation was found between the indices in the two examinations and with respect to point-by-point analysis (Figs. 3 and 4, Table 1). The correlation coefficient between both tests for mean defect (MD) was 0.97 and between the square roots of the loss of variance (sLV) was 0.90. G1-TOP produced, on average, a mean sensitivity 0.45dB thresholds higher than did G1-bracketing. This difference was variable depending on the location of the point, decreasing to 0.18dB in those points located at less than 15° from fixation and increasing to 0.68dB in those points located between 15 and 30°.

Normal individuals had the same MD (G1-TOP versus G1-bracket: 0.2 ± 1.0dB and 0.2 ± 1.5dB) (p>0.05), and the LV value was significantly smaller with TOP (G1-TOP versus G1-bracket: 4.3 ± 4.1dB and 11.0 ± 13.0dB) (p<0.05).

Mean duration of the test for G1-TOP was 2:19 ± 0:36 minutes, while G1-bracketing took 11:15 ± 1:17 minutes (relation G1-TOP/G1-bracketing: 1/4.9, or a net reduction of 79.4%).

Discussion

One of the main problems facing automated perimetry testing is the time involved in obtaining an approximation of the visual field sensitivity threshold. Complaints from

| Table 1. Correlation coefficient between the perimetric indices obtained with G1-TOP and G1-bracketing |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|                 | Total | MD     | MD     | MD     | MD     | MD     | MD     | sLV    | Threshold |
|                 | r     | SE     | r      | SE     | r      | SE     | r      | SE     | r      | SE     | r      | SE     |
| TOP versus      | 0.97  | 1.52   | 0.96   | 2.15   | 0.95   | 2.08   | 0.95   | 1.95   | 0.96   | 1.88   | 0.90   | 1.17   | 0.85   | 4.18   |
| bracketing      |       |        |        |        |        |        |        |        |        |        |        |        |        |

r: correlation coefficient; SE: standard error YX (dB)
Fig. 3. Scattergrams for the MD values.

Fig. 4. Point-by-point analysis: histogram of frequency with the threshold differences between G1-TOP and G1-bracketing thresholds.
most patients, but particularly from the elderly (the most frequently affected by the
diseases we are interested in testing), are well known to any clinician using automated
perimetry. Apart from patients’ poor acceptance of the test, reliability of the results
might also decrease due to neuronal fatigue and attention loss.

One of the most frequently used perimetric tests at present (program G1) takes an
average of 11 minutes per eye. In this test, although only 59 locations are tested with
the conventional bracketing strategy, more than 300 stimulus presentations are fre-
quently required to approximate the threshold (minimum: 200; maximum: 500). G1-
TOP obtains equivalent results in a fifth of the time.

Similarly to what has been observed with other perimetric strategies which cut test
time, G1-TOP obtains threshold sensitivity values that are slightly higher, and mean
defect values that are lower, than those obtained with the conventional strategy3-12.
These differences are usually attributed to the different strategies. Although it is prob-
able that the origin of this difference is a result of a reduced ‘fatigue effect’ which
falsely decreases the threshold sensitivity in a long perimetric test13-15.

Favoring this explanation would be the fact that the differences between both types
of perimetry increase in the peripheral areas of the visual field. ‘Fatigue effect’ behaves
in a similar way and is larger in the most peripheral points13,14.

TOP is currently one of the fastest available strategies and is the most constant in
duration. It has been suggested that the perimetric variability should be reduced in
order to avoid an irregular influence of the fatigue effect on the results16.

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