COMPARATIVE EVALUATION OF FOUR STRATEGIES (STANDARD, DYNAMIC, TOP, 2-LEVEL) USING THE AUTOMATED PERIMETER OCTOPUS 1-2-3

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Abstract

The dynamic strategy and tendency-oriented perimetry (TOP) are new programs designed to reduce the test duration of perimetry. The authors compared these new strategies with standard and 2-level strategies in both normal subjects and glaucoma patients. They studied 25 eyes of 25 normal subjects (24-61 years of age) and 48 eyes of 29 glaucoma patients (28-76 years of age). They measured the visual fields using four strategies (standard 4-2, dynamic, TOP and 2-level) and compared their test durations, numbers of questions, sensitivities and specificities. The authors also studied the correlation of mean defect (MD) and loss variance (LV) between the standard strategy, dynamic strategy and TOP. The dynamic strategy showed a 30% decrease in test duration compared with the standard strategy. TOP had a test duration of only three to four minutes for all examinations. In early glaucoma patients, the sensitivities of the dynamic strategy and TOP were equal to the sensitivity of the standard strategy. In glaucoma patients at stage I of Aulhorn’s classification, modified by Greve, the sensitivities of the dynamic strategy and TOP were 95%. However, the specificity of TOP was low (78.6%). The correlation of MD between the standard strategy, dynamic strategy and TOP was excellent. The coefficients of correlation between the standard strategy and the dynamic strategy were 0.98 (MD) and 0.96 (LV), and those of correlation between the standard strategy and TOP were 0.95 (MD) and 0.89 (LV). The dynamic strategy and TOP are useful programs for reducing the test duration of perimetry.

Introduction

In Octopus perimetry, the 4-2dB step double-crossing staircase algorithm is the standard method for determining the threshold of differential light sensitivity. However, this strategy takes almost 15-20 minutes per eye to measure the central 30° visual field. This long test duration is one of the primary problems of automated perimetry.

Recently, several new algorithms which reduce test duration have been developed. In 1989, Weber et al. developed the ‘dynamic strategy’ and, in 1996, González de la Rosa et al. developed tendency-oriented perimetry (TOP)\(^1\). The Swedish Interactive

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Threshold Algorithm (SITA) was developed by Bengtsson et al. for the Humphrey Field Analyzer\(^2\). In the present study, we compared the dynamic, TOP and 2-level strategies with the standard 4-2 strategy in normal subjects and glaucoma patients.

**Subjects and methods**

**Normal subjects**

Measurement was carried out in a total of 25 eyes of 25 normal subjects. The mean age of the study population was 36.6 ± 12.3 years (minimum, 24 years; maximum, 61 years). The inclusion criteria were as follows: pupil diameter of \( \geq 3.0 \) mm; corrected visual acuity of \( \geq 20/20 \); refractive errors of \( \leq 3.0 \) D (spherical) and \( \leq 3.0 \) D (cylindrical), and clear optical media.

**Glaucoma patients**

Measurement was carried out in a total of 48 eyes of 29 glaucoma patients; 28 eyes of 16 patients with primary open-angle glaucoma, 18 eyes of 11 patients with normal-tension glaucoma, and two eyes of two patients with primary angle-closure glaucoma. The stages of their visual field defects were as follows: four eyes with stage 0-I, 16 eyes with stage I, 14 eyes with stage II, seven eyes with stage III, five eyes with stage IV, and two eyes with stage V, according to Aulhorn’s classification, modified by Greve et al.\(^4\). The mean age of the study population was 56.5 ± 12.3 years (minimum, 28 years; maximum, 76 years). The inclusion criteria were as follows: pupil diameter of \( \geq 3.0 \) mm; corrected visual acuity of \( \geq 20/30 \); refractive errors of \( \leq 9.0 \) D (spherical) and \( \leq 3 \) D (cylindrical), and clear optical media.

**Visual field tests**

The standard 4-2dB step double-crossing staircase algorithm was used to determine the differential light sensitivity. In 2-level strategy, the test results were classified as ‘normal sensitivity’, ‘relative defect’, and ‘absolute defect’. Additional measurements were carried out for the purpose of evaluating the threshold of the test points of relative defect. In the dynamic strategy, the staircase step size varies between 2dB at normal values and 10dB toward the lowest sensitivity level. The TOP algorithm assesses the visual field by asking only one question per test location. Each answer is used to modify the test and neighboring locations.

In this study, we measured the visual fields with program No. 32 of the Octopus 1-2-3. Using these four strategies, we measured the visual fields of normal subjects and glaucoma patients and compared their test durations, numbers of questions, sensitivities and specificities. These four strategies were tested randomly within a month. We studied the correlation of mean defect (MD) and loss variance (LV) between the standard strategy, the dynamic strategy and TOP. We also studied the correlation of short-term fluctuation (SF) between the standard and dynamic strategies.

In order to evaluate the sensitivity and the specificity of these new strategies, we divided the visual fields into four quadrants using the horizontal and vertical meridians. The cut-off criteria for abnormality were as follows: two or more adjacent test locations of more...
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Results

Clinical cases

Case 1 was a 49-year-old male with open-angle glaucoma in his right eye. His right visual field showed an advanced sensitivity loss in the upper nasal visual field according to the standard strategy of the Octopus 1-2-3. Dynamic, TOP and 2-level strategies showed almost the same result as the standard strategy. The test duration was 22 minutes and 51 seconds for the standard strategy, 13 minutes and 47 seconds for the dynamic strategy, three minutes and 38 seconds for TOP, and seven minutes and 40 seconds for the 2-level strategy (Fig. 1).

Case 2 was a 54-year-old female with normal-tension glaucoma in her left eye. Standard, dynamic and 2-level strategies showed a sensitivity loss with local absolute defects in her upper field. TOP also showed the sensitivity loss in her upper visual field. However, local absolute defects were not detected by TOP. The test duration was 22 minutes and ten seconds for the standard strategy, 14 minutes and 21 seconds for the dynamic strategy, three minutes and 21 seconds for TOP, and four minutes and 40 seconds for the 2-level strategy (Fig. 2).

Table 1 shows the average number of questions with these four strategies in normal subjects and glaucoma patients. The dynamic strategy showed a 30% decrease in the number of questions compared to the standard strategy.
of questions compared with the standard strategy. With the 2-level strategy, there were 86 questions in normal subjects. This number increased in advanced glaucoma patients. In TOP, there were 81 questions in all subjects.

Table 2 shows the sensitivity and the specificity of the dynamic, TOP and 2-level strategies, compared with the standard strategy. In advanced glaucoma patients, the sensitivity of all strategies was 100%. In early glaucoma patients, the sensitivities of the dynamic strategy and TOP were 95%. However, the specificity of TOP was low (78.6%).

In glaucoma patients, the correlation of MD and LV among the standard strategy, dynamic strategy and TOP was excellent (Figs. 3 and 4). The coefficients of correlation between the standard and dynamic strategies were 0.98 (MD), 0.96(LV), and those between the standard
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Table 2. Sensitivity and specificity of dynamic, TOP and 2-level strategies compared with the standard strategy

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Sensitivity</th>
<th>Specificity (%)</th>
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<tbody>
<tr>
<td></td>
<td>Stage 0–1–I (n=20)</td>
<td>Stage II–V (n=28)</td>
</tr>
<tr>
<td>dynamic</td>
<td>95</td>
<td>100</td>
</tr>
<tr>
<td>2-level</td>
<td>85</td>
<td>100</td>
</tr>
<tr>
<td>TOP</td>
<td>95</td>
<td>78.6</td>
</tr>
</tbody>
</table>

strategy and TOP were 0.95 (MD), 0.89 (LV). The values of SF were significantly higher for the dynamic strategy than for the standard strategy (p<0.001). The values of LV were significantly lower for TOP than for the standard strategy (p<0.001) (Wilcoxon rank sum test).

Discussion

The dynamic strategy showed about a 30% decrease in the test duration compared to the standard strategy. The accuracy of the dynamic strategy was almost comparable to that of the standard strategy. However, values of SF were significantly higher for the dynamic strategy than for the standard strategy in glaucoma patients. In 1996, Zulauf et al. reported that the dynamic strategy required 43% fewer stimuli and increased SF by 23%. With the dynamic strategy, the staircase step size varies between 2 and 10dB. The large step sizes are used when evaluating advanced glaucomatous visual field defects. We assumed that this high SF was due to the large step sizes used in advanced glaucomatous visual field defects.

With TOP, the test duration was three to four minutes in all subjects. The sensitivity was almost the same as for the dynamic strategy. However, our data showed that the specificity of TOP was low. We assumed that this low specificity of TOP was due to our strict cut-off criteria for abnormal visual fields. When TOP is used, each test point is examined only once. If the patient answers incorrectly during the initial stage, the sensitivity near this point will be decreased. Therefore, it is very important to monitor patient responses during the examination. If the patient answers incorrectly during the initial stage, it is recommended that the testing be repeated. In this study, we measured the visual fields with TOP program version 1.0. With TOP program version 2.0, abnormal points in the first matrix are retested. In glaucoma patients, the correlation of MD and LV between the standard strategy and TOP was excellent. However, the values of LV were significantly lower in TOP. LV is the index for evaluating localized loss in the visual field. The same result was obtained in the visual fields of Case 2. With the TOP algorithm, the threshold value of one test point was determined by the patient’s responses in the neighboring area. Therefore, it is theoretically difficult to evaluate one or two points of absolute defect using TOP.

With the exception of these limitations, the dynamic strategy and TOP are considered to be quite useful in reducing the test duration of perimetry.
Fig. 3. Correlation of MD, LV and SF between the standard and dynamic strategies.
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Fig. 4. Correlation of MD and LV between the standard strategy and TOP.

References