COMPARISON OF SITA AND DYNAMIC STRATEGIES WITH
THE SAME EXAMINATION GRID

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Abstract

Two new fast, yet informative, visual field strategies were compared. Ten normals, 25 neuro-ophthalmological patients and 95 glaucoma patients with various stages of disease severity were tested with the Swedish Interactive Threshold Algorithm (SITA) strategy of the Humphrey Field Analyzer-750 Program 30-2 and with the dynamic strategy of the Octopus-101 Program 32 with the same test locations on the same day.

Results: More early defects were found with the dynamic strategy than with the SITA strategy. On the other hand, for the severe local defects, the dynamic strategy gave a lower estimate of the defect depth than the SITA strategy.

Introduction

It is generally accepted that, in automated perimetry, threshold measurements render the most accurate representation of the visual field. However, full-threshold strategies are often time-consuming, while faster or shorter strategies provide less precise information.

Recently, two strategies were developed which allow for shorter examination time without loss of information: the Swedish Interactive Threshold Algorithm (SITA) strategy of the Humphrey Field Analyzer (HFA), and Weber’s dynamic strategy used with the Octopus perimeter. With the SITA strategy, time is saved by using a priori knowledge about normal values and frequency-of-seeing curves, and by using all responses given to estimate the expected deviations in threshold values and threshold error estimates. Longer test time is spent on locations in which inconsistent responses are given. With the dynamic strategy, time is saved by using large step sizes in deep defects and by limiting the time-consuming 2dB steps to areas of shallow defects and normal values. After the threshold has been crossed once, the final threshold is determined as the mean between the last seen and the last non-seen stimulus.

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We recently had the chance to compare the SITA strategy with the dynamic strategy in well-documented patients, using the same examination grids for both strategies. Our purpose was to provide additional comparative data as a basis for choosing the optimal strategy in daily practice.

Methods

In our perimetry unit, we work with the HFA-750 and regularly use the SITA strategy for examination of our glaucoma and neuro-ophthalmological patients. During a two-month period in the spring of 1998, we also had an Octopus-101 perimeter available for visual field testing.

Strategies and programs used

For the HFA, we used the 30-2 Program with the SITA standard strategy. For the Octopus, we used Program 32 with the dynamic strategy. The 30-2 and 32 programs both test the same stimulus locations. All subjects were tested with both perimeters on the same day, with a short break between examinations. The order of the field tests depended upon which perimeter was available first. All subjects were familiar with automated perimetry. One eye per patient was tested.

Patients

All glaucoma or neuro-ophthalmological patients who were scheduled for visual field testing during the two-month period were tested with both strategies. This included all patients who met the following criteria: diagnosis of ocular hypertension (pressures over 21 mmHg, normal disc, no field defects), glaucoma suspects (suspect disc, no field defects), or early to severe glaucoma. Glaucoma patients were classified according to severity of the tested eye into: no defect (Class 0), minimal defect (Class 1), early defect (Class 2), moderate defect (Class 3), and severe defect (Class 4). The objective criteria used for this classification were those described by Hodapp et al. for the HFA. Neuro-ophthalmological patients were all those attending our special neuro-ophthalmology clinic. In this manner, 95 glaucoma patients (mean age 60 years), 25 neuro-ophthalmological patients (mean age 54 years), and ten normal volunteers (mean age 52 years) recruited from our department, were examined.

Analysis

Our original aim was to do a point-by-point comparison of the two strategies, since they measure exactly the same test locations, by using the threshold values available on disc. However, we could not access the necessary software for executing a transfer of data. Therefore, we entered the indices for general and local loss, as well as test time, into a spreadsheet program by hand. For the HFA, we used the mean deviation (-MDH) and the pattern standard deviation (PSD); for the Octopus, we used the mean defect (MDO) and the square root of the loss variance (sqrLV). Scatterplots were generated for the comparisons.
Fig. 1. Comparison of the square root of the loss variance of the Octopus (Y-axis) with the pattern standard deviation of the Humphrey Field Analyzer (X-axis) for glaucoma patients and normals. The straight line is the line x=y.

Fig. 2. Comparison of the square root of the loss variance of the Octopus (Y-axis) with the pattern standard deviation of the Humphrey Field Analyzer (X-axis) for neuro-ophthalmological patients.
Fig. 3. Comparison of the mean defect of the Octopus (Y-axis) with the (minus) mean deviation of the Humphrey Field Analyzer (X-axis) for glaucoma patients and normals.

Fig. 4. Comparison of the mean defect of the Octopus (Y-axis) with the (minus) mean deviation of the Humphrey Field Analyzer (X-axis) for neuro-ophthalmological patients.
### Table 1. Mean and standard deviation data for the normals, glaucoma patients and neuro-ophthalmological patients

<table>
<thead>
<tr>
<th>No.</th>
<th>Age</th>
<th>-MD(dB)</th>
<th>MD(dB)</th>
<th>Diff</th>
<th>PSD</th>
<th>vLV</th>
<th>Diff</th>
<th>Time</th>
<th>Time</th>
<th>Diff</th>
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<tr>
<td>Normals</td>
<td>10 Mean</td>
<td>51.9</td>
<td>0.12</td>
<td>0.81</td>
<td>0.69*</td>
<td>1.59</td>
<td>2.11</td>
<td>0.52*</td>
<td>6:28</td>
<td>6:33</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>14.16</td>
<td>0.66</td>
<td>0.69</td>
<td>0.99</td>
<td>0.26</td>
<td>0.45</td>
<td>0.36</td>
<td>0:42</td>
<td>0:43</td>
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<tr>
<td>Glaucoma Class 0 (no defect)</td>
<td>16 Mean</td>
<td>51.6</td>
<td>0.52</td>
<td>2.09</td>
<td>1.57*</td>
<td>1.92</td>
<td>3.72</td>
<td>1.8*</td>
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<td>7:21</td>
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<tr>
<td></td>
<td>SD</td>
<td>12.91</td>
<td>1.01</td>
<td>1.93</td>
<td>1.55</td>
<td>0.36</td>
<td>1.23</td>
<td>1.08</td>
<td>0:52</td>
<td>0:55</td>
</tr>
<tr>
<td>Glaucoma Class 2 (early defect)</td>
<td>17 Mean</td>
<td>64.9</td>
<td>2.08</td>
<td>4.01</td>
<td>1.93*</td>
<td>2.95</td>
<td>4.10</td>
<td>1.15*</td>
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</tr>
<tr>
<td></td>
<td>SD</td>
<td>14.66</td>
<td>1.79</td>
<td>2.26</td>
<td>1.92</td>
<td>0.95</td>
<td>1.01</td>
<td>1.04</td>
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<tr>
<td>Glaucoma Class 3 (moderate defect)</td>
<td>26 Mean</td>
<td>63</td>
<td>4.52</td>
<td>6.30</td>
<td>1.78*</td>
<td>5.74</td>
<td>5.87</td>
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</tr>
<tr>
<td></td>
<td>SD</td>
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<td>1.86</td>
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<td>1.95</td>
<td>2.98</td>
<td>1.71</td>
<td>2.10</td>
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<tr>
<td>Glaucoma Class 4 (severe defect)</td>
<td>36 Mean</td>
<td>60.1</td>
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<td>15.13</td>
<td>-0.73</td>
<td>11.15</td>
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<td>2.67</td>
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<td>1.62</td>
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<tr>
<td>Neuro-ophthalmological patients</td>
<td>25 Mean</td>
<td>53.8</td>
<td>8.76</td>
<td>9.14</td>
<td>0.38</td>
<td>5.96</td>
<td>5.58</td>
<td>-0.38</td>
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<td>7:27</td>
</tr>
<tr>
<td></td>
<td>SD</td>
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<td>9.89</td>
<td>8.02</td>
<td>2.85</td>
<td>4.22</td>
<td>2.68</td>
<td>2.52</td>
<td>1:23</td>
<td>1:32</td>
</tr>
</tbody>
</table>

*Significant p < 0.05 (double-sided t test). No glaucoma patients tested were classified as Class 1.
Results

Local defects

Figure 1 shows, for the glaucoma patients, the relationship between local defects found with the two methods. The straight line is the line $x=y$. More localized loss was found at the early stages with the Octopus dynamic strategy than with the HFA SITA strategy. On the other hand, for the more advanced stages, the dynamic strategy gives a lower estimation of localized loss than the SITA strategy. A similar picture for the neuro-ophthalmological patients can be seen in Figure 2.

Overall loss of sensitivity

Figure 3 shows the relationship between overall loss of sensitivity found with the two methods for the glaucoma patients. The straight line is the line $x=y$. This figure shows a similar trend as that seen in Figure 1 for the differences in the mean defect and mean deviation variables, i.e., the Octopus dynamic strategy indicates more overall loss in the early stages of visual field loss and less overall loss in the later stages, as compared with the HFA. A similar picture is seen again in Figure 4.

Test time

For normal fields and fields with early defects, the test time was comparable between the two strategies, but fields with more severe defects took less time with the dynamic strategy. The mean values and standard deviation of the indices and the test time and their differences are shown in Table 1. Mean differences indicated with an asterisk (*) are statistically significant ($p<0.05$ using the double-sided $t$ test).

Discussion

The HFA and the Octopus are two widely used perimeters. Therefore, not surprisingly, comparative studies of groups of subjects have been conducted. Vivell et al.\cite{4} published a study on the conversion of normal data. Anderson et al.\cite{5} studied threshold equivalents in 12 normals and 37 early glaucoma patients tested with four perimeters. The best correlation was found for the HFA 30-2 and Octopus 32 programs, with the same test locations, but the authors emphasize that the complexity of comparison between perimeters remains tedious, and may be even more difficult for points with reduced sensitivity. Zeyen et al.\cite{6} tested 12 normals and 38 mild-to-moderate glaucoma patients with the HFA 24-2 and Octopus G1 programs, and constructed conversion formulas for thresholds and indices to be used for the prediction and comparison of individual subjects tested with both programs.

In the present study, we chose the SITA strategy of the HFA (Program 30-2) and the dynamic strategy of the Octopus (Program 32) as two fast, yet informative, strategies, and tested the same locations in the $30^\circ$ visual field, and compared them with respect to local defects, general reduction of sensitivity, and test time.
For both local and general defects, and all patient groups, we found that the dynamic strategy showed more mild defects than SITA did. This is best shown in Figure 1, which depicts the local defects found in glaucoma patients and normals. The normals in Figure 1 score about equal for both strategies. However, for most glaucoma patients with early or moderate defects, the dynamic strategy indicated a higher local defect value than the SITA strategy. We speculated that the difference is due to the well-known fact that there is a lot of fluctuation of thresholds in areas of relative local defects in glaucoma patients. The dynamic strategy determines the threshold value after the threshold has been crossed only once. The SITA strategy follows a much more complicated algorithm; it uses prior knowledge about models of normal and glaucomatous visual fields, as well as all responses given during the test to estimate the threshold behavior in a certain location. If measurement error estimates during the test are smaller than the levels set in the model, the test procedure is stopped after one response reversal. However, if measurement errors are larger, more time is spent testing the location (two response reversals). This would mean that threshold estimates not in conformity with the estimated population behavior receive less weight than those that do conform with the model. The strategy does not seem to accept outlying values at face value, but tests them more elaborately. In principle this would apply to both positive and negative outliers. But since, in early glaucoma, it is more usual to find threshold estimates below rather than above the normal values, negative outlying values would usually be less readily accepted. It could be imagined that the outlying values represent fluctuation in early defects and that continued testing reduces their chance of being determined as a defect location or underestimates the defect. Since we have no short-term fluctuation data available for the subjects studied here, we could not elaborate on this possibility further. If points detected with the dynamic strategy as early defects were indeed tested more elaborately with the SITA strategy, it might be expected that SITA would have a longer overall test time for the early glaucoma classes. However, this was not the case.

Another difference observed in Figure 1 is that, for patients with severe glaucoma, with deep defects, the dynamic strategy estimated the local defects to be less deep than those measured with the SITA strategy. Speculatively again, we thought this might be explained because the dynamic strategy explores the severe defects with large step sizes. It should be pointed out that the dynamic strategy does forego some accuracy in determining severe defects by using large step sizes with the conscious intention of saving time. This was confirmed by our data which show a shorter test time with the dynamic strategy in patients with severe defects (Table 1).

Conclusions

In glaucoma and neuro-ophthalmological patients, the dynamic strategy seems to detect early defects better than SITA. The dynamic strategy seems to underestimate severe defects, but has a shorter test time.

References