Visual field assessment – a comparative study of four perimeters

Dr Michael Wolfe compares four perimeters and finds that their speed of operation vary significantly

Assessment of the state of the visual field is one of the most important parts of any ocular examination. It provides information about the function not only of the eye but also of the brain itself. It enables predictions to be made about future clinical developments; it is a key element in making prognoses. Failure to detect developing field changes can have disastrous consequences both for the patient and for the practitioner.

Over the past two decades, methods of examining the visual field have changed out of all recognition. While hand-held techniques can still produce useful and valid information, automation is now the rule rather than the exception. The use of threshold and supra-threshold techniques have enabled defects to be picked up far earlier than was previously possible. While threshold techniques have been around for a long time, their use was limited by the fact that they were time-consuming and demanding for the patient. As a result of automation, a threshold examination can now be completed in a fraction of the time that was previously involved.

The time taken to complete a visual field examination is critical. Notwithstanding the introduction of sophisticated automated perimeters, visual field examination still remains subjective. Patient cooperation is essential. An inattentive subject will produce misleading or totally spurious results. The quicker the examination, the less fatigued the patient, the more reliable and accurate the results are likely to be.

There are many automated perimeters and field screeners on the market and this study looked at four to compare the results they produced and the time they took to carry out the same or similar examinations on a sample of subjects. The instruments were the Dicon LD 400, the Henson Pro, the Humphrey Field Analyzer II 720 and the Oculus Centrefield. The sample of subjects included some with established field defects and some with normal fields.

INSTRUMENT FEATURES

The perimeters involved are of a similar size, and fit comfortably on a standard instrument table. The Oculus, Dicon and Humphrey have their computers built in, while the Henson employs a separate external computer. The Humphrey has its printer incorporated while the others use external printers. With all the perimeters the results can be stored for later recall and comparison analysis, although the Dicon requires the purchase of its optional FieldView system. As a result of this storage and recall facility, the results can be presented in many forms – for example, in grey scales, numerical decibel (dB) values or progressive displays showing how the field is changing with time.

The Oculus and the Humphrey use a 30cm radius bowl. The Dicon also has a 30cm working distance but uses a flat screen rather than a bowl. All three use the Goldmann standard background illumination of 31.5 apostilbs (asb), with a variable luminance of the stimulus up to a maximum of 10,000asb. The Henson uses a 25cm radius bowl and has a background luminance of 10asb with a maximum stimulus luminance of 3,150asb.

All the perimeters incorporate numerous programmes and test strategies covering the central and peripheral fields. In the Henson the central field covered is normally 25°, but in one case – the Armaly test – it extends to 30°. In all the other perimeters the central field covers 30°. The monocular peripheral field can be examined out to 60° in the Dicon and Henson, to 70° with the Oculus and 55° with the Humphrey 72°, although this can be extended to 86° in other versions of this instrument.

All have threshold and supra-threshold programmes. With the Oculus, Dicon and Henson instruments, supra-threshold strategy is carried out at 5dB brighter than the threshold. With the Humphrey, this is set at 6dB brighter.

The Dicon and the Henson have a facility for multiple stimulus testing in which up to four stimuli are presented at the same time. With the Henson this is limited to the central 25°, but with the Dicon the full field out to 60° can be screened in this way. With the Dicon the procedure is fully automated. The patient simply has to identify the number of points seen but is not required to identify their location; this is done automatically by the computer. With the Henson, in order to locate a defective area the patient has to identify the position of the points seen.

The Dicon has a moving fixation spot whereas with the others the fixation point generally remains fixed. Both static and kinetic perimetry can be carried out with the Oculus Centrefield. A blue stimulus can also be used. These features, while not available on the Humphrey 720 model, are available on more expensive versions of the Humphrey Analyzer.

METHOD

The sample comprised 25 adults who were examined on all four perimeters. The results were analysed to see how they compared in terms of their similarities and the time taken to complete each examination. So that a meaningful comparison could be made, it was decided to use a supra-threshold test covering the central 30°. This meant that with the Henson Pro, the only appropriate test which covered 30° was the Armaly test. The tests for comparison should ideally have the same number of stimuli and the tests chosen were based on this approach. This criterion could be met with the Humphrey and the Dicon instruments, the comparative tests each having 80 stimuli, but the nearest that could be achieved with
the Henson was a test with 76 points and with the Oculus, 77 points.

Two of the perimeters have a facility for multiple stimulus presentation. These tests are designed to speed up the examination. The Dicon procedure is fully automated, the perimeter being programmed to determine which test points are missed without any question being put to the patient. This programme was therefore used because of its apparent speed. The equivalent programme with the Henson is not automated. The operator must ask the patient to identify the position of the test points that are seen and clearly this increases the time taken when a defect is present and was therefore considered to be inappropriate for comparison purposes. In any event the field covered is only 25° rather than the 30° required.

The following tests were chosen for comparison:

- Oculus Centrefield 30-2 – single stimulus
- Dicon LD 400 80/30 – multiple stimulus
- Henson Pro Armaly test – single stimulus
- Humphrey FA 720 Central 80 point screening – single stimulus.

All of these programmes involve a strategy of automatically quantifying any defects by finding the defect's threshold value. With the Dicon and Humphrey, this value is determined as a result of a full threshold in the density of the defect. With the Henson and the Oculus, this is a bracketed value. With the Henson, if the test point is not seen, its luminance is increased in two steps – first to 8dB above the original threshold and finally to a level 12dB above the initial threshold. With the Oculus, the luminance is increased in 5dB steps until seen or until the maximum brightness is reached.

To limit the effect of fatigue, only one eye of each subject was examined at any one time. For the same reason, each subject was examined on only two perimeters on any one visit. After each examination, the subject was given a rest period of not less than 30 minutes. To avoid bias in terms of fatigue, the perimeter being used first for each subject was alternated; for example, if the Dicon and Humphrey were being used together, half the subjects were examined first on the Dicon with the others examined first on the Humphrey.

RESULTS

Of the 25 subjects examined, seven were found to have full normal fields on all four instruments. Eight subjects had field defects that were detected on all the perimeters. Five of these had significant established field loss while three subjects presented with early field defects. The results from the remaining 10 subjects were mixed: field defects were identified with some instruments, while on others the fields appeared to be full and normal. Of these mixed results, seven subjects showed either very early defects or normal fields. The defects, where detected, were reasonably consistent between instruments, but in one case there was little consistency, indicating that either the findings were spurious or field losses were in their very early stages. Of the remaining three cases, definite field losses were detected with three perimeters with one showing a normal field. The reverse was shown in the other two cases with one perimeter showing a definite field loss while the others showed virtually normal fields.

NORMALS: For the seven subjects, who were found to have no field defects on any perimeter, the critical factor was the time taken to complete the examination. In all cases the first stage of the examination procedure involves establishing the threshold as a means of carrying out the test at the appropriate supra-threshold level. This stage is carried out automatically. In the Dicon, Henson and the Humphrey, the testing process follows the thresholding stage without pausing. In the case of the Oculus, after the thresholding stage, the testing stage requires the operator to start the process, which is then completed automatically (Table 1).

In all cases the Oculus Centrefield was consistently the fastest instrument, being between 30 and 80 per cent faster than its nearest rival. Compared to the other instruments, its variation in time was also the least, its range varying by no more than 10 seconds between subjects. The Henson with one exception, the second fastest, followed by the Dicon. The Humphrey, with one exception, was the slowest in all cases. It had been expected that the multiple pattern testing procedure used in the Dicon, which does not involve any questioning by the operator, would be the fastest. In fact, in only one case was it faster than the other three instruments.

**Confmed field defects**: In the eight cases that displayed consistent field defects, the time taken to complete the examination was longer than the times taken to check those with normal fields (Table 2). This was to be expected, since the programmes chosen automatically quantify the missed points. This procedure involves rechecking the initial result to confirm whether the result is false – perhaps due to momentary inattention. If the result is confirmed, then this area is thresholded in order to identify the density of the defect.

Once again the Oculus was consistently the fastest instrument. With one exception, the Henson was the second fastest. The Dicon and Humphrey instruments were the slowest, the third and fourth places being equally divided. Compared to the Henson, the Oculus varied from being 12 to 80 per cent faster. Compared to the other two perimeters the Oculus was between 29 and 270 per cent faster – ie almost four times as fast. The fact that the Dicon and Humphrey were so much slower than the Oculus can partly be explained by the fact...
that unlike the Oculus and Henson, they fully threshold the missed points as opposed to bracketing them. The variation between subjects in time taken was also the least with the Oculus, this being 1 min 11 secs. This compared to 3 min 20 secs for the Henson, 7 min 47 secs for the Dicon and 10 min 36 secs for the Humphrey.

Mixed results: With the group of results which showed a lack of consistency between instruments, the differences in time taken to complete each examination was much smaller than was the case with the other two groups – normals and confirmed defects (Table 3).

For the 10 subjects involved, the Oculus was equal fastest with the Dicon and Henson in two cases and was fastest in six of the others. The margins, however, in five of these was much less than had previously been found – being between 21 and 52 seconds faster than its nearest competitor. Overall, the Henson was the second fastest with the Dicon and Humphrey equal third, their times being roughly equally divided.

DISCUSSION

This study looked at just one of the many programmes that each instrument is capable of performing. Bearing in mind that these instruments carry out subjective testing of the visual field, patient cooperation is essential for useful results. Patient fatigue will always affect the accuracy of the findings and this must be borne in mind. For this reason only one programme was chosen and that was a static screening test of the central 30°, but one that was enhanced by thresholding any missed points.

Accuracy always presents a problem in as much as in the absence of any objective method of measuring the visual field, there is no absolute value against which subjective results obtained with different instruments can be judged. The measure that was used in this study was simply to compare the findings and to see to what extent they were similar or identical. Of the sample of 25 subjects, 28 per cent had absolutely normal fields while 32 per cent showed field defects on all the instruments.

The field defects shown, however, were not absolutely identical. In the remaining 40 per cent of cases, defects were detected on some instruments but not on others. It was not possible to identify which of the perimeters were the most accurate. In all 10 cases the results were of such a nature that the field defects were not sufficiently definite for a diagnosis to be made on the basis of these findings alone. Further checks would be required in order to verify whether the defects were real or spurious due perhaps to patient fluctuation.

The results in terms of time taken were in some ways very surprising. It had been expected at the outset that in the detection of normal fields, the multiple stimulus testing procedure used with the Dicon LD 400 which does not involve any questioning of the patient by the practitioner, would be faster than tests which involve single stimulus presentation. The basis of this assumption was that with as many as four stimuli being presented at any one time, the field would be covered more rapidly than with a single stimulus and the time taken to complete would be significantly less than the other tests methods. This did not prove to be the case. The Oculus Centrefield was consistently and significantly faster than any other instrument for both normal and field defect groups, even allowing for the separation of the thresholding and the actual testing. This thresholding stage took approximately 30 seconds; a total of 45 seconds, however, was added to the recorded time for the Centrefield to ensure that the comparisons between instruments were on a like for like basis. The fact that the Dicon and Humphrey were so much slower than the Oculus and Henson can, in part, be accounted for by the fact that both instruments fully threshold the missed points. With the Oculus the threshold process is in 5dB intervals – this could involve between two and six steps. In the case of the Henson the stimulus is increased in only two steps – to 8dB and 12dB above threshold. On top of this, both the Henson and the Oculus tested slightly fewer points than the other perimeters – 76 and 77 points respectively compared to 80. This would result in a small saving of time amounting to 5 per cent for the Henson and 3.75 per cent for the Oculus.

Even allowing for these factors, the differences in time – with the Dicon being as much as 7 min 35 secs slower than the Oculus and the Humphrey 10 min 27 secs slower – were larger than expected.

In the group where the results were inconsistent in as much as defects were not found with all instruments and no one instrument gave consistent findings, the time differences between instruments were far less. Nevertheless the Oculus was between 21 seconds and 1 min 39 secs faster than the next fastest in six of the 10 cases. In two more cases the Oculus was equal first with the Dicon and Henson respectively. In the remaining two cases the Dicon was 52 secs and the Henson 50 secs faster than the Oculus. The fact that the times were that much closer would support the concept that patient fluctuation was a factor.

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Dr Michael Wolff is an optometrist and scientific and training consultant

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**TABLE 3**

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<thead>
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<th>Subject</th>
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