Confrontation Visual Field Loss as a Function of Decibel Sensitivity Loss on Automated Static Perimetry

Implications on the Accuracy of Confrontation Visual Field Testing

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Purpose: To evaluate the accuracy of confrontation visual field testing with regard to the density of the visual field defect and its location in the peripheral visual field.

Methods: A prospective comparison of confrontation visual field testing with full-threshold Humphrey automated static perimetry C24-2 or C30-2 was conducted at a university eye center over a 3-month period. Seventy-two patients with a variety of neurologic and ophthalmologic conditions underwent confrontation visual field testing and automated perimetry as a part of their evaluation. One visual field from each patient was analyzed for this study.

Results: Confrontation visual field testing yielded an overall sensitivity for detecting an abnormal visual field (full-field analysis) of 63%, when sensitivity of confrontation testing rested on the detection of just one abnormal quadrant. The sensitivity of confrontation testing varied depending on the type of visual field loss present: 51% for arcuate scotomas, 67% for visual field constriction, 78% for altitudinal scotomas, and 90% for hemianopias. The sensitivity of detecting abnormal visual field quadrants, rather than the full-field analysis, was, however, poor at 38%. The sensitivity of confrontation testing was lower for superior quadrant defects and higher for inferior quadrant defects. The estimated probability of detecting an abnormal visual field quadrant occurring at a −26-decibel sensitivity loss from age-matched healthy patients for superior quadrant defects and a −19-decibel sensitivity loss for inferior quadrant defects was 50%. The increased sensitivity noted for visual field defects and for inferior quadrant defects appears to be related, in part, to the density of the visual field loss present.

Conclusion: Confrontation visual field testing is relatively insensitive unless a moderate to dense defect is present, and as such is a poor screening test. However, when visual field defects are identified with confrontation visual field testing, the defects often are real as per the high specificity (97%) and high positive predictive value (96%).

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The identification and subsequent determination of the extent of visual field loss are important in managing intraocular or intracranial disorders such as glaucoma, optic neuritis, ischemic optic neuropathy, compressive optic neuropathy, strokes, and tumors. Confrontation visual field testing is performed easily and is considered by some to be an integral part of a routine ophthalmologic examination. Some authorities even consider confrontation visual field testing to be "an excellent screening procedure that should be performed on every patient seen by the ophthalmologist." At the 1994 International Neuro-Ophthalmology Society Meeting (Freiburg, Germany), there was almost unanimous agreement among neuro-ophthalmologists on using confrontation visual field testing. But how good is confrontation visual field testing?

The accuracy of confrontation visual field testing has been examined previously by comparison with Goldmann kinetic perimetry and automated static perimetry for a variety of disorders affecting the visual pathway. The sensitivity of confrontation visual field testing was reported to be high for lesions affecting the posterior visual pathway producing hemianopias and low for anterior visual pathway lesions producing arcuate scotomas. The range of sensitivities and specificities reported by these studies may reflect the type of visual field defect present, the density of the visual field loss present, or both. It therefore would be of interest to know the sensitivity of confrontation visual field for differing densities of visual field defects, and to ascertain whether this sensitivity is the same in all quadrants of the visual field. In the current study, we prospectively assessed the sensitivity of confrontation visual field testing both as a function of the type of visual field defect present, and as a function of the density of the visual field loss present.

Subjects and Methods

This prospectively designed study involved 72 consecutive patients who were evaluated by the Neuro-Ophthalmology Service during a 3-month period for a variety of disorders. All subjects fulfilled the following enrollment criteria: (1) visual acuity of better than 20/200; (2) satisfactory completion of both confrontation visual field testing and full-threshold Humphrey automated static perimetry (Allergan Humphrey, San Leandro, CA) program C24-2 or C30-2 with size III stimulus; and (3) no more than one of the following three parameters—fixation losses, false-positive errors, or false-negative errors—having greater than 20% error during automated perimetry. Humphrey automated perimetry was performed under intermittently monitored conditions as previously described. The visual field of one eye from each patient was chosen randomly for analysis, if both eye visual fields fulfilled the requirement of a good visual field. The examiner in each case was unaware of the patient's automated perimetric result.

The technique of confrontation visual field testing has been described previously with modification. Confrontation visual field testing was performed with the examiner sitting approximately 70 cm in front of the patient. The examiner simultaneously presented his index fingers in a region 15° to 25° eccentric from fixation in opposing quadrants of the visual field of the monocularly viewing patient. A self-check of the examiner's blind spot—approximately 12° to 15° from central visual axis—allowed for proper positioning of the examiner's hands in the patient's peripheral field. The patient was asked to maintain fixation on the examiner's opposing eye and identify which of the examiner's fingers wiggled (oscillation < 5°). All four quadrants were tested in at least two locations. If the patient was unable to reproducibly identify the finger that wiggled in a quadrant, that quadrant was deemed defective. We did not attempt to identify the pattern of visual field defect (e.g., hemianopia), but only screened for the presence or absence of a visual field defect. The central 15° of vision were not assessed by this confrontation technique, and therefore will not be reported here.

The Statpac 2 program of the Humphrey automated perimeter computes a numeric total deviation map and a corresponding total deviation probability map (Fig 1) by comparing the differences in threshold sensitivity and the probability of a point defect, respectively, with normal findings of age-matched visual field quadrants stored in its database. Using the decibel sensitivity loss values provided in the Statpac 2 numeric total deviation map while excluding the central 15°, because this area was not tested by this confrontation technique, we identified the median (50th percentile) value of the recorded decibel sensitivity losses for each quadrant as indicated in Figure 1. Similar to the identification of the median decibel sensitivity loss for each quadrant on the numeric total deviation map, the median probability symbol representation of each visual field quadrant on the total deviation probability map also was identified (Fig 1). The median probability symbol representation on the total deviation probability map was used to define normal and abnormal quadrants of the visual fields as indicated in Figure 1. If the median probability symbol of a visual field quadrant, excluding the central 15° area, had an associated probability value of 5% or less (P ≤ 0.05), then that quadrant was defined as abnormal. Visual field quadrants with median probability symbols of greater than 5% probability (P > 0.05) were defined as normal. The visual field itself was defined as abnormal when at least one quadrant of the visual field was deemed abnormal or defective. When all four quadrants of the visual fields were free of defects, that visual field was considered normal. Visual field defects were classified as arcuate, altitudinal, constriction (circular-ferential loss of light sensitivity encroaching within 18° of fixation), or hemianopia (Fig 1). If two differing visual field patterns were identified in the same visual field (e.g., superior altitudinal and inferior arcuate), the visual loss was ascribed to the predominant or denser visual field defect.

The sensitivity of confrontation visual field testing was calculated for the type of visual field defect present (i.e., full-field analysis) and for each quadrant, using automated static perimetry as the "gold standard." The specificity, positive predictive value, and negative predictive value
Figure 1. Humphrey automated perimetry C24-2 or C30-2 visual fields show right eye arcuate (column A), left eye altitudinal (column B), right eye constriction (column C), and left eye hemianopic (column D) visual field defects. Top, gray scale representation of the visual field defect. Middle, the numeric total deviation map. Bottom, the total deviation probability map. Center and Bottom rows are obtained by comparing the differences in threshold sensitivity and probability of a point defect, respectively, to age-matched normal visual fields stored in the computer database. The central 15° of vision (within the circles) were not assessed by this confrontation technique, and therefore were excluded from analysis. The median value of decibel sensitivity losses for each quadrant on the numeric total deviation map (center) was identified and denoted by the bold number in each quadrant. A normal (N) visual field quadrant had a median probability symbol representing greater than 5% probability (P > 0.05). An abnormal (Y) visual field quadrant had a median probability symbol of 5% or less (P ≤ 0.05).

Results

Of the 72 visual fields from the 72 subjects (age: mean ± standard deviation, 60.4 ± 18.0 years; range, 20–91 years) who met the eligibility criteria, 63 (87.5%) were abnormal with defects on automated perimetry in at least one quadrant. There were 9 (12.5%) altitudinal scotomas, 35 (48.6%) arcuate scotomas, 9 (12.5%) visual field constrictions, and 10 (13.9%) hemianopic field defects. Results of the remaining nine (12.5%) automated perimetric tests were normal. There were 181 abnormal visual field quadrants and 107 quadrants without defects, based on the median defect test of the total deviation probability map (Fig 1).

The overall sensitivity of confrontation visual field testing for detecting abnormal visual fields (full-field analysis) was 63%. The sensitivity of confrontation visual field testing varied, depending on the type of visual field loss present (Table 1), being 51% for arcuate scotomas, 67% for visual field constriction, 78% for altitudinal scotomas, and 90% for hemianopias, but these were not significantly different (P = 0.11, Fisher's exact test). With regard to the abnormal visual field quadrants for the four types of

<table>
<thead>
<tr>
<th>Visual Field Defect</th>
<th>No. of Subjects</th>
<th>No. of Abnormal Quadrants</th>
<th>Median Decibel Sensitivity Loss Mean ± SD</th>
<th>Median Decibel Sensitivity Loss (°)</th>
<th>Sensitivity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arcuate</td>
<td>35</td>
<td>91</td>
<td>-14.9 ± 7.8</td>
<td>-4 to -33</td>
<td>51</td>
</tr>
<tr>
<td>Constriction</td>
<td>9</td>
<td>35</td>
<td>-24.3 ± 6.3</td>
<td>-10 to -32</td>
<td>67</td>
</tr>
<tr>
<td>Altitudinal</td>
<td>9</td>
<td>27</td>
<td>-16.7 ± 6.6</td>
<td>-6 to -28</td>
<td>78</td>
</tr>
<tr>
<td>Hemianopia</td>
<td>10</td>
<td>28</td>
<td>-23.9 ± 8.6</td>
<td>-4 to -34</td>
<td>90</td>
</tr>
<tr>
<td>Overall</td>
<td>63</td>
<td>181</td>
<td>-18.4 ± 8.6</td>
<td>-4 to -34</td>
<td>63</td>
</tr>
</tbody>
</table>

SD = standard deviation.
visual field defects, the mean of the median decibel sensitivity loss from age-matched normal visual field quadrants has been summarized in Table 1: arcuate scotomas, \(-14.9 \pm 7.8\) decibels (dB) (range, \(-4\) to \(-33\) dB); altitudinal scotomas, \(-16.7 \pm 6.6\) dB (range, \(-6\) to \(-28\) dB); hemianopias, \(-23.9 \pm 8.6\) dB (range, \(-4\) to \(-34\) dB); and visual field constriction, \(-24.3 \pm 6.3\) dB (range, \(-10\) to \(-32\) dB). Significant differences in the means of the median decibel sensitivity loss among the four types of visual field defects were noted (\(P < 0.0001\)). The high sensitivity for hemianopias may reflect the greater degree of decibel sensitivity loss, whereas the lower sensitivity for arcuate scotomas may reflect the lesser degree of decibel sensitivity loss.

Although the sensitivity of confrontation testing for various types of visual field defects appeared to be good (51%–90%), it should be recalled that for this full-field analysis, an abnormal visual field on confrontation testing rested on the detection of just one abnormal quadrant. A better assessment of the accuracy of confrontation visual field testing would be obtained from an assessment of the sensitivity of detecting abnormal visual field quadrants rather than full-field analysis. Here, the overall sensitivity of confrontation visual field for detecting an abnormal visual field quadrant was 38%. The quadrant sensitivity varied, depending on which visual field quadrant was defective (Table 2). The sensitivity of confrontation visual field was lower for superior quadrant defects (superotemporal, 27%; superonasal, 35%) and higher for inferior quadrant defects (inferotemporal, 43%; inferonasal, 44%). These results are consistent with the logistic regression analysis described below which controls for the decibel sensitivity loss in examining quadrant effects. The mean ± standard deviation of the median decibel sensitivity loss from age-matched normal visual fields for defective quadrants is summarized in Table 2: superotemporal, \(-20.2 \pm 8.1\) dB; superonasal, \(-18.7 \pm 7.2\) dB; inferotemporal, \(-17.8 \pm 8.9\) dB; and inferonasal, \(-17.2 \pm 9.3\) dB. No significant differences (\(P = 0.30\)) were noted in the means of the median decibel sensitivity loss among the quadrants.

Figure 2 provides estimates of the probability of identifying a visual field defect, depending on the quadrant affected and the density of the defect encountered as determined by a multiple logistic regression model. For simplicity, it was assumed that responses for quadrants within the same individual were independent. The Hosmer-Lemeshow goodness-of-fit test indicated a fair fit (\(P = 0.050\)). The model documents that as the density of the visual field defects increases, so does the probability of obtaining a positive confrontation visual field. The estimated 50% probability of detecting a visual field defect occurred at a median decibel sensitivity loss from age-matched normal visual fields of \(-26.0\) dB for superotemporal defects, \(-25.1\) dB for superonasal defects, \(-19.2\) dB for inferonasal defects, and \(-18.5\) dB for inferotemporal defects.

Confrontation visual field testing based on quadrant analysis yielded a high specificity of 97% and high positive predictive value of 96%, indicating that defects identified by confrontation testing were most often real defects. On the contrary, confrontation visual field testing yielded a low negative predictive value of 52%, based on quadrant analysis, indicating that a defect was present almost 50% of the time, despite confrontation testing, suggesting a normal visual field.

**Comment**

Confrontation visual field testing is a rapid and inexpensive method of detecting visual field defects. The actual method of performing confrontation visual field varies among clinicians. Trobe and co-workers investigated the accuracy of various confrontation techniques in detecting chiasmal and optic nerve defects and found no significant difference in sensitivity with kinetic boundary testing, static single-quadrant finger counting, and simultaneous two quadrant counting. A significant improvement was noted with the use of static and kinetic color confrontation techniques, as had been suggested previously by Frisén. The method of kinetic testing by Trobe et al was different from that used in the current study, making direct comparisons difficult. We used the oscillating (wiggling) finger.
technique because of the ease of performance, even for individuals with severe neurologic deficits and children. The study sought to correlate confrontation visual field kinetic testing with decibel sensitivity loss from age-matched normal visual fields on automated static perimetry within the region 15° to 25° eccentric to fixation.

Various investigators have reported higher confrontation visual field sensitivities for posterior than anterior defects.\(^\text{2,3,6}\) For example, Johnson and Baloh\(^\text{3}\) noted high sensitivity (75%) for detecting homonymous hemianopias, whereas the accuracy of arcuate scotoma and bitemporal hemianopsia was low (20%-50%). By combining static central visual field testing, these investigators obtained 100% sensitivity for detecting two types of anterior visual pathway defects, namely altitudinal and central scotomas.\(^\text{3}\)

Although we did not include the central 15° of the visual field in the analysis, the sensitivities obtained in the current study approximated other studies with regard to the four types of visual field defects that were assessed.\(^\text{2,3,6}\) Our study concurred with Johnson and Baloh,\(^\text{3}\) indicating that the detection rate of visual field defects depends on the type of visual field defect present. However, the differences appear to result from the density of the visual field defects present. Our data indicated that the estimated probability of confrontation visual field testing identifying a defective visual field quadrant with 50% accuracy occurred at a median decibel sensitivity loss of −19 dB for inferior quadrant defects and −26 dB for superior quadrant defects (Fig 2). The mean defect density of hemianopic visual field loss in this study from retrochiasmal disorders such as parietal or occipital lobe strokes was −23.9 dB, resulting in a greater likelihood of being detected by confrontation testing. However, less dense hemianopias which may occur from parasellar lesions would be more difficult to detect. This would account for the 58% to 96% sensitivity noted in this and other studies with regard to the combined detection of homonymous hemianopias and bitemporal hemianopias.\(^\text{2,3,6}\)

Arcuate scotomas in this study were not as dense as hemianopias, with the mean decibel sensitivity loss for arcuate scotomas being −14.9 dB. Because the estimated 50% probability for detecting a field defect corresponds to a minimum of −19 dB or denser defect, it is not surprising that arcuate scotomas often go unnoticed on confrontation visual field testing.\(^\text{2,3}\) Glaucoma and compressive optic neuropathies often present initially with arcuate scotomas; therefore, reliance on confrontation visual field testing for detection (or monitoring) of these diseases would be contraindicated.

Our data indicated that the quadrant location of the visual field defect may influence the likelihood of detection by confrontation visual field testing. The superior quadrants had the lowest detection rates, whereas the inferior quadrants yielded the highest sensitivity by confrontation visual field testing. It should be noted that the decibel sensitivity loss among the four quadrants was not significantly different. This may suggest that the greater likelihood of detecting visual field defects in the inferior quadrants than the superior quadrants may simply reflect an artifact of the method of confrontation visual field testing. However, it is known that there is greater threshold sensitivity in the inferior visual field than the superior visual field in the healthy population.\(^\text{7-9}\) Thus, the difference in sensitivities between the superior and inferior quadrants may be a physiologic characteristics of motion (or static) perception related to retinal or other neural processing.
Shahinfar et al. Confrontation Visual Field

Full-threshold automated static perimetry is the most sensitive method of detecting visual field defects within the central 30°. A drawback of the full-threshold automated static perimetry is the relatively long duration required for testing of each eye, making it less useful as a screening tool. An easily portable, reliable, and reproducible screening test would be desirable. Recently, Vernon and Quigley compared the oculokinetic perimetry test, a hand-held screening visual field test, with the Humphrey C24-2 and C30-2 programs. To our knowledge, this is the first study providing a point-for-point comparison of a nonautomated screening perimetric test with full-threshold Humphrey automated static perimetry within the region 12.5° and 15° eccentric to fixation. The oculokinetic perimetry test resulted in 100% sensitivity in identifying field defects in individuals with glaucoma when there was -21 dB or denser visual field loss. In comparison with the oculokinetic perimetry test, the confrontation visual field test performed in this study resulted in an estimated probability of detecting a visual field defect ranging from 25% in the superotemporal quadrant to a high of 63% in the inferotemporal quadrant when the visual field defect is -21 dB.

Confrontation visual field testing is sensitive for very dense visual field defects of either the anterior or the posterior visual pathway. Confrontation visual field testing is insensitive (<50% probability of detection) for mild to moderate scotomas of up to a -19-dB sensitivity loss in the inferior visual quadrant, and for even dense scotomas of up to -26 dB in the superior visual field. Noting that a -20-dB loss represents 10² or 100-fold reduction in brightness sensitivity, the clinician performing confrontation visual field test should be cognizant that confrontation visual field testing is a poor screening test, which will miss early visual field defects. The low negative predictive value of 52% indicates that the lack of identification of a field loss on confrontation testing should not be interpreted as an absence of visual field defect. Despite this limitation, if confrontation visual field testing is performed, the clinician could confidently believe that defects identified on confrontation testing are real, relating to the high specificity of 97% and high positive predictive value of 96%. In addition, the sensitivity of detecting a visual field defect is greater in the inferior quadrants of the visual field. Further studies are needed to determine whether this difference in sensitivity for particular regions of the visual field is due to inherent physiologic differences or a result of the method of testing.

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References