

Comparison of an automated confrontation testing device versus finger counting in the detection of field loss

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KEYWORDS

Confrontation visual field testing;
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Perimetry;
Glaucoma;
Automated confrontation test;
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Abstract

PURPOSE: The aim of this study was to compare an automated confrontation visual field testing (ACV) device with traditional finger-counting confrontation visual field testing (FCV).

METHODS: Forty-five eyes of 45 subjects with glaucoma, 5 eyes of 5 subjects with neurologic disease and 15 eyes of 15 normal subjects (age matched to the subjects with glaucoma by frequency) were tested on both ACV and FCV. All subjects with glaucoma and neurologic disease had visual field loss on white-on-white Humphrey perimetry (HVF). The FCV was performed in 8 meridians in a normally lighted room, whereas ACV was performed in a darkened room. The ACV device consisted of a black rectangular box with 4 1.0-mm red light-emitting diodes at each corner and a fixation hole at the center. Four automated randomized presentations were presented, and the subject was asked to identify the number of red lights seen (from 1 to 4). Any point missed on any of the presentations on either test was recorded as a failure.

RESULTS: All normal subjects passed both tests. FCV detected field loss in 33.0% of glaucomatous eyes, whereas ACV detected field loss in 58% of glaucomatous eyes ($P < 0.001$). Subjects with glaucoma who passed FCV but failed ACV had an average mean deviation of -7.77 dB on HVF, compared with subjects who failed both FCV and ACV, who had an average mean deviation of -19.74 dB on HVF ($P < 0.001$). All subjects with absolute visual field loss because of advanced glaucoma or neurologic disease failed both tests. No subject who passed ACV failed FCV.

CONCLUSIONS: Gross confrontation visual field testing using an automated testing device has a greater sensitivity in the detection of moderate visual field loss than finger counting confrontation visual fields. *Optometry 2007;78:390-395*

Determination of visual field loss is an important part of a comprehensive eye examination. Routine threshold or screening visual fields, which are time consuming, have not been shown to be cost effective because of their relatively low detection rates. On the other hand, gross confrontation visual field testing is rapid and inexpensive to perform and

has thus been designated as an essential part of a comprehensive eye examination.¹

Gross confrontation visual field testing has not been standardized, because clinicians tend to vary targets or testing techniques.² Targets have included fingers (either stationary or oscillating), the palms of the hand, the examiner's face, and illuminated white or colored stimuli. Presentation of stimuli may be kinetic or static, involve 1 quadrant at a time, or have simultaneous presentation in 2 quadrants. Some clinicians present 1 target in 1 quadrant, whereas others use a multitude of targets; some test close to

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the visual axis, whereas others test the whole central field. The testing distance may also vary from clinician to clinician and from subject to subject.

Johnson and Baloh³ compared the sensitivity and specificity of confrontation visual fields using wiggling or oscillating fingers presented simultaneously in opposing visual hemifields with automated static perimetry. They found that the sensitivity of confrontation visual field testing depended on the type of visual field defect present. For example, sensitivity was high for altitudinal field loss, central scotoma, and homonymous hemianopias but was poorer in detecting arcuate scotomas (typically found in glaucomatous field loss) and bitemporal hemianopsia.

Shahinfar et al.⁴ performed confrontation visual field testing using oscillating fingers in opposing quadrants, which they also compared with automated perimetry. They reported that confrontation visual field testing was relatively insensitive to mild to moderate visual field defects (<26 dB defect on automated perimetry). Sensitivity was high for altitudinal and hemianopic defects but not as good for arcuate scotoma.

In both of the previous studies, the *specificity* was high; thus, when a field defect was identified, it was a true defect. However, confrontation visual field testing using fingers failed to detect the visual field defect in the majority of patients who did not have dense visual field defects, or who had arcuate field loss, as would be found in glaucoma. Visual field defects caused by chiasmal and postchiasmal lesions, which typically are dense, were easy to detect. Confrontation visual field testing is not standardized, is subject to examiner variability and choice of testing stimulus, and has been shown to be insensitive to shallow field loss.

With this in mind, one of the authors of this study (J.C.) designed the Automated Confrontation Visual Field Tester (ACV). The ACV is cost effective and simple to use, requiring very little training or experience. Because it is automated, examiner variability is not as much of an issue as it is with finger-counting or finger-oscillation confrontation visual field testing. The ACV also makes use of red diodes as stimuli. The basis for the use of red targets lies in the work of others.

Pandit et al.⁵ compared 7 methods of confrontation visual field testing against the results achieved with static automated perimetry in patients with small or shallow field loss. These methods included the use of the examiner's face, quadrant finger counting, kinetic finger moving, red color comparison, and kinetic red and white targets. They found the most sensitive confrontation method was examination of the central 20 degrees using a small (5 mm) red target. Trobe et al.⁶ investigated the use of saturation differences in red squares presented simultaneously in 2 separate quadrants and compared this method with finger counting in chiasmal hemianopic and nerve fiber layer defects. Although the sensitivity of the red targets was double that of finger counting for the chiasmal defects, color targets were only slightly more accurate than finger counting in the

detection of nerve fiber bundle defects. Other studies have found that small red objects are more sensitive in the detection of both neurologic and glaucomatous field loss.⁷⁻⁹

The purpose of the current study was to determine whether the ACV, with its automated program and small red stimuli, would improve the detection rate of visual field loss in subjects with glaucoma with established, reproducible visual field loss on automated perimetry, using Humphrey Visual Field (HVF) testing compared with gross confrontation visual field testing using finger-counting field testing (FCV). It was also compared with FCV in patients with absolute field loss (neurologic disease) and in normal subjects with no visual field loss.

Methods

After the approval of this study by the Institutional Review Board (IRB) of the State University of New York (SUNY) State College of Optometry for the protection of human subjects, patients with glaucoma and patients with neurologic field loss were identified by screening records from the Glaucoma and Neurology Clinics, respectively. Normal subjects were recruited from the college community. All subjects read and signed consent forms.

Forty-five eyes of 45 subjects with a diagnosis of glaucoma and visual field loss on HVF standard automated perimetry (SAP), 5 eyes of 5 subjects with neurologic field loss on HVF, and 15 eyes of 15 normal subjects (25 to 55 years of age) with no visual field loss on HVF were tested and were age matched to the subjects with glaucoma by frequency. The neurologic conditions of the subjects in the group with neurologic field loss included anterior ischemic optic neuropathy, cerebrovascular accident, and head trauma secondary to motor vehicle accidents. These subjects were free of dense media opacities, retinal disease, and glaucoma. Subjects in the glaucoma group with glaucomatous field loss who had dense media opacities, retinal disease, or optic nerve disease (other than glaucoma) were excluded from the study. Any children younger than 18 years were also excluded from the study. All normal subjects were examined and were free of any ocular disease. Any subject deemed normal (free of ocular disease) who had an unreliable or abnormal HVF result was also excluded from the study.

The 3 visual field tests that were used in this study are detailed below.

HVF (Humphrey SITA 24-2)

Swedish Interactive Threshold Algorithm (SITA) Standard HVF 24-2, white-on-white, HVF tests were performed previously on both the subjects with glaucoma and subjects with neurologic disease who participated in this study. All HVF tests had been performed within a 3-month period before the subject was tested with FCV and the ACV.

Normal subjects were tested using the HVF 24-2 SITA Fast program after FCV and ACV. We chose the fast strategy to confirm that the normal subjects did not have any field defects. Subjects with disease had already had SITA Standard visual fields performed as a part of their clinical care.

FCV (finger-counting field testing)

Traditional finger-counting gross confrontations was performed with the examiner seated 60 cm from the subject at the subject's eye level in a well-lit room. Subjects were instructed to occlude the left eye and look at the examiner's left eye with the right eye. The examiner held up 1 or 2 fingers using 1 or both hands in 4 quadrants (inferotemporal, inferonasal, superotemporal, and superonasal) midway between the examiner and the subject. This was originally performed with fingers presented in 1 quadrant only and then 2 quadrants simultaneously. The subjects were asked to count the number of fingers seen. The same procedure was also performed on the left eye (if both eyes were being tested) by having the subject look at the examiner's right eye with the left eye. A failure was recorded when the subject missed 1 or more fingers on any of the presentations. Only a pass or fail was recorded, not the location of the defect. There were 3 different examiners, but all performed the testing as directed by a set of detailed written instructions.

ACV (automated confrontation field testing)

The ACV device consisted of a black box that measured 12 cm by 17 cm. Four 1.0-mm red light-emitting diodes (LEDs) were positioned 11.25 cm apart, which resulted in an angular separation of 15° at 60 cm. A peephole located in the center served as a fixation point for the subject and a fixation monitor for the examiner (see Figure 1). The stimulus size and color red were chosen because small red objects have been shown to be most sensitive in the detection of both neurologic and glaucomatous field loss.⁶⁻⁸ The place-



Figure 1 The automated confrontation field tester.



Figure 2 Examination of a subject using the ACV field tester.

ment of the LEDs was positioned so they could be easily seen by a normal subject in all of the 4 quadrants.

The subject was seated in a darkened room with the left eye occluded and instructed to look at the central peephole with the right eye. The examiner sat at a distance of 60 cm and viewed the subject through the central peephole to ascertain fixation (see Figure 2). At this testing distance, the stimuli, which were 11.25 cm apart, tested the central 15°. The examiner then pressed a button to randomly present from 1 to 4 of the LEDs. Because the device was automated, the examiner had no control over the number and position of the lights that were presented during each trial. The subject then reported the number of lights seen. The examiner then recorded the subject's responses based on the red diodes that lit up on the rear panel of the device (see Figure 3). If the subject's response was correct, another presentation was performed until 4 presentations were completed. If the subject missed 1 or more of the stimuli, the subject was then asked to state the location of the lights seen, to ascertain which stimuli were missed for purposes of recording the responses on a recording sheet (see Figure 4). However, in all, only 4 presentations were performed in total per eye. After the right eye was tested, the subject then occluded the right eye, and the left eye was tested. Missing any light

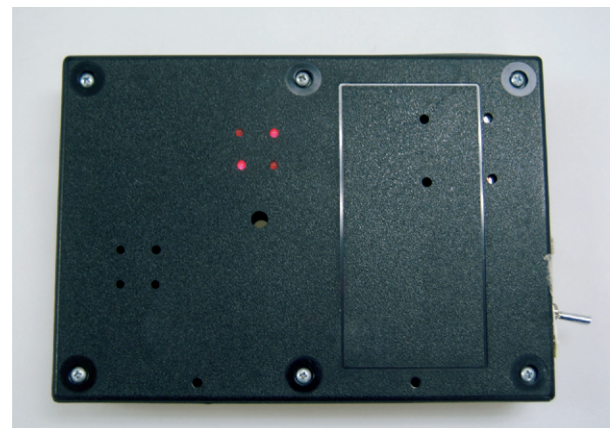


Figure 3 Examiner's view of the LED pattern seen by the patient.

Eye Tested	Presentation 1	Presentation 2	Presentation 3	Presentation 4
OD	• •	• •	• •	• •
OS	• •	• •	• •	• •

Figure 4 The recording form for the ACV tester. Seen stimuli were circled; missed stimuli had an “x” drawn through the spot.

presented during any of the 4 trials per eye constituted a failure.

All subjects who participated were tested initially with FCV followed immediately by the ACV. This order of testing was maintained because the study subjects with glaucoma or neurologic disease had already had FCV and HVF performed during the treatment of their glaucoma, or to identify a neurologic disease, and within 3 months of their participation in this study. To maintain consistency of testing order, the normal subjects were also tested first with FCV and then with the ACV.

For the subjects with glaucoma and for the normal subjects, an unbiased examiner “blind” to each subject’s identity and disease status reviewed all visual field results separate from any other testing results and classified the HVF as glaucomatous or normal. This was done to ascertain the accuracy of the HVF in identifying a pattern of field loss associated with ocular disease and to remove bias from knowing which subjects had disease and which subjects were normal.

Results

Ability (percent failed) of FCV to identify visual field abnormalities in eyes of a glaucomatous population

FCV detected visual field loss in 33% of glaucoma eyes with glaucomatous field loss on Humphrey visual fields (see Table 1). The other 67% of glaucoma eyes passed FCV testing. All normal eyes did not have visual field loss on Humphrey visual fields and also passed FCV (i.e., no failures). These findings were statistically significantly different from chance (Chi-square corrected, $df = 1, P < 0.001$, Phi-square = 0.11—the phi coefficient is a measure of the extent of association or relation between 2 sets of

Table 1 Ability (percent failed) of finger-counting (FC) visual field testing to identify visual field abnormalities in a glaucomatous population

	HVF	
	Glaucoma	Normal
Failed	33	0
Passed	67	100

Table 2 Ability (percent failed) of automated confrontation testing (AC) to identify visual field abnormalities in a glaucomatous population

	HVF	
	Glaucoma	Normal
Failed	58	0
Passed	42	100

attributes measured on a nominal scale and is similar in meaning to Pearson’s correlation coefficient r).

Ability (percent failed) of ACV to identify visual field abnormalities in eyes of a glaucomatous population

ACV detected visual field loss in 58% of glaucomatous eyes in subjects with glaucomatous field loss as determined by HVF (see Table 2). The other 42% of glaucomatous eyes passed ACV. All normal eyes did not have a visual field loss on Humphrey visual fields and also passed ACV (i.e., no failures). These findings were statistically significantly different from chance (Chi-square corrected, $df = 1, P < 0.001$, Phi-square = 0.26).

Percentage of agreement between FCV and ACV for glaucomatous eyes

Of all the glaucoma eyes tested, 55% failed both FCV and ACV; the remaining 45% of eyes failed only ACV. No eyes that passed ACV failed FCV (0%), whereas all eyes (100%) that passed ACV also passed FCV (see Table 3). These findings were statistically significantly different from chance (Chi-square corrected, $df = 1, P < 0.001$, Phi-square = 0.43).

Percentage of agreement between an independent observer and HVF results for glaucomatous and normal eyes

An independent observer, blind to the disease status of the subjects, categorized each visual field as glaucomatous or normal. Glaucomatous visual field loss was identified cor-

Table 3 Percentage of agreement between AC and FC

	AC	
	Failed	Passed
FC		
Failed	55	0
Passed	45	100

Table 4 Percentage of agreement: independent observer and HVF assessment

	Independent observer	
	Glaucoma	Normal
HVF		
Glaucoma	95	8
Normal	5	92

rectly for 95% of eyes. Five percent of fields of the glaucomatous eyes were deemed to be normal. Ninety-two percent of normal visual fields from the 15 eyes of the normal patients were identified correctly, whereas 8% of these visual fields were categorized as being glaucomatous (see Table 4). These findings were not statistically significantly different from chance (McNemar, $P < 0.579$), meaning there was no difference between assessment of disease state by HVF and by the independent observer.

The overall difference in HVF mean deviation (MD) among all subjects with glaucoma classified by the independent observer as either having a significant glaucomatous HVF defect (MD = -11.73, SD = 7.60) or not (MD = -1.43, SD = 1.63) was statistically significant. (Wilcoxon matched Pairs, $t = 27$, $P < 0.001$.)

Average of the mean deviation on HVF of glaucomatous eyes detected with FCV versus ACV

The average of the mean deviation on HVF was determined and compared among 3 groups of subjects with glaucoma. For those subjects passing both FCV and ACV, the average of the mean deviation on HVF was -7.03 dB, SD = 5.37, N = 21 eyes. For those subjects failing both FCV and ACV, the average of the mean deviation on HVF was -19.74 dB, SD = 6.35, N = 14 eyes. For the group of subjects who passed FCV and failed ACV, the average of the mean deviation on HVF was -7.77 dB, SD = 4.01, N = 10 eyes (see Figure 5). There were no subjects who passed ACV and failed FCV; hence, there was no fourth group. An analysis of variance (ANOVA) between these 3 independent groups was statistically significant ($F [2,42] = 25.38$, $P < .001$). Tukey HSD paired comparison post hoc tests found statistically significant differences between 2 paired comparisons: (1) subjects who passed both tests versus those who failed both tests ($P < 0.001$) and (2) subjects that failed the ACV but passed the FCV versus those that failed both tests ($P < 0.001$).

Percentage of agreement between HVF, ACV, and FCV in eyes with neurologic field loss

Both FCV and ACV detected field loss in 100% of eyes with neurologic field loss on HVF. There was, therefore, 100% agreement (1) between HVF loss and FCV testing, (2)

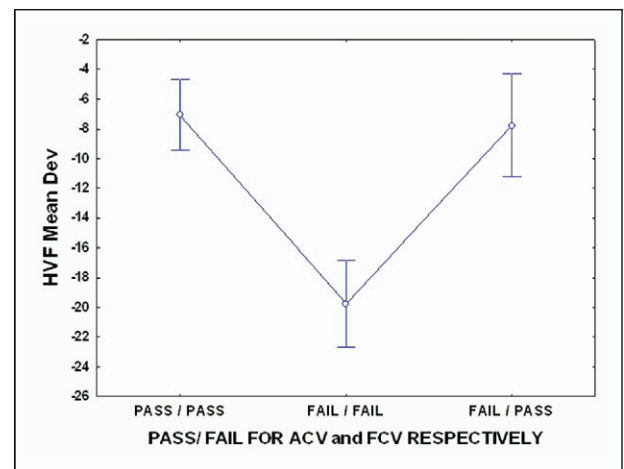


Figure 5 Graph comparing the average mean deviation on HVF with 3 groups of subjects: those who passed ACV and FCV (PASS/PASS), those who failed ACV and failed FCV (FAIL/FAIL), and those who failed ACV but passed FCV (FAIL/PASS).

between HVF loss and ACV testing, and (3) between FCV and ACV.

Discussion

Gross confrontation visual field testing using large targets, such as finger counting, will identify only large dense visual field defects. To detect smaller relative scotomas, a confrontation visual field test has to have greater sensitivity. The ACV in this study (which was comprised of small, red targets separated by 15°, a technique similar to the “best” confrontation visual test suggested by Pandit et al.⁵) was able to detect visual field defects more often than traditional gross confrontation visual field testing with fingers. Our results are similar to those of Pandit et al.⁵ who found that the most sensitive method of visual field screening in patients with shallow field loss was examination of the central 20° using a small red target.

Lee et al.¹⁰ used a red laser pointer target projected onto a tangent screen as a stimulus for gross confrontation visual fields in patients with defects on automated perimetry. Kinetic presentation of stimuli was followed by a static, randomized presentation that straddled both vertical and horizontal meridians, areas around the blind spot, in each quadrant, and near central fixation. The average test time was 1.5 minutes per eye. They reported a sensitivity of 73% for the laser pointer versus 31% for finger-counting visual fields. The ACV in the current study showed a sensitivity of 58% versus 33% for finger-counting visual fields. Although the sensitivity of using the laser pointer visual field screening was 15% higher than using our ACV (73% for the laser pointer versus 58% for the ACV), the ACV does not require a tangent screen.

All normal subjects passed both FCV and ACV. When a visual field defect was identified with either test, it was a

“real defect,” i.e., both tests had a specificity of 100%. These results are similar to those of other previously described studies^{3,4} that reported a high specificity in patients having various ophthalmologic and neurologic disorders using finger-counting confrontation with simultaneous presentation in opposing quadrants.

The ACV had a greater rate of detection of visual field loss in subjects with glaucoma compared with FCV. This is likely because of the use of small red diodes that have been shown in previously mentioned studies to increase sensitivity.^{5,10} The ACV was also more sensitive for glaucomatous loss with a lower average mean deviation on Humphrey visual field testing compared with FCV. Therefore, the ACV detected moderate glaucomatous damage earlier in the disease than with FCV. FCV only detected visual field loss in advanced glaucomatous eyes and in patients with neurologic disease with high average mean deviation and deeper, absolute field loss. It should be noted that subjects with very early glaucomatous visual field loss (low average mean deviation) passed both FCV and ACV testing. However, as seen in Figure 5, the average MD on HVF of the group of subjects who passed FCV but failed ACV was only slightly greater than those glaucomatous subjects who passed both ACV and FCV (−7.77 dB vs. −7.03 dB, respectively).

This study did not address the ability of the ACV to correctly identify the location of a field defect. The purpose of this study was to evaluate the ability of the ACV to screen both neurologic and glaucoma defects. In clinical application, missing any presentation (regardless of the location) would alert the clinician to perform a more sensitive threshold visual field test.

The light weight and portability of the ACV make it ideal for use in underdeveloped countries where the cost of automated testing devices precludes visual field testing. Its main advantage is the standardized way stimuli are presented. It runs on a 9-volt battery and does not require access to electricity. It is small—about the size of a calculator—and takes up little space. It is simple to manufacture, costs little, is easy to use, and requires minimal training. The ACV, therefore, may offer an advantage in disease detection in countries that have little or no resources for the implementation of sophisticated visual field testing. To determine whether the ACV would be useful in such settings, it would be appropriate to test it on a mission like those done by VOSH (Volunteer Optometric Services to Humanity).

In developed countries, where the standard of care is confrontation visual field testing, this device may better

detect more relative visual field loss. We recognize that a full visual field screening would likely be more effective in the detection of relative visual field loss. However, full visual field screenings are not the standard of care on every patient, take several minutes to perform, and are not cost effective.

Conclusions

The ACV is a fast method for performing gross confrontation visual fields and shows greater sensitivity in a small group of subjects with glaucomatous field loss compared with gross confrontation testing using finger counting.

The ACV, like FCV, will detect dense or absolute visual field loss in patients with neurologic disease and advanced glaucoma, but ACV has the additional advantage over FCV in the ability to better detect relative visual field loss, as may be found in moderate glaucoma. The design, portability, and ease of use of the ACV make it a useful and sensitive confrontation visual field testing device serving clinical settings in both underdeveloped and developed countries.

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