British Journal of Ophthalmology, 1991, 75, 558-560

Association of Vistech contrast sensitivity and visual field findings in glaucoma

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Abstract

Single eye visual fields and contrast sensitivity were assessed in 60 subjects, who were being followed up in a glaucoma clinic for manifest glaucoma or a suspicion of glaucoma because of raised intraocular pressure. The Fieldmaster 5000 (static/kinetic perimeter) was used for the visual fields, and a Vistech wall chart sine wave grating test was used for contrast sensitivity measurements. The subjects were divided into three groups - defect (D), suspect (S) and normal (N) - on the basis of their perimetric findings by subjective grading of 16 perimetric scoring categories for each visual field. The mean Vistech sensitivity levels were not found to be significantly different between the D, S, and N field subgroups at any of the five spatial frequencies provided on the test charts (1·5, 3, 6, 12, and 18 cycles per degree). Complex algorithms combining results from two or more spatial frequencies also failed to yield any significant differences between the groups. Diagnostic sensitivity and specificities relating Vistech contrast sensitivity findings to groups N and D never concomitantly exceeded 60%.

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Accepted for publication 30 May 1991

Measurement of the visual fields is the principal method for confirming the presence and progression of glaucoma. Despite recent advances in computerised visual field analysis, perimetric studies remain time consuming and demand complex subjective interpretation. Psychophysical research has revealed abnormalities in contrast sensitivity in association with glaucoma and ocular hypertension.[1-6] Recently clinical methods for presenting static contrast gratings on wall charts have been introduced.[7,8] One of these is the Vistech sine wave grating method. Bron has reported that oscilloscopic and Vistech methods discriminate glaucomatous from ocular hypertensive eyes equally well.[9] The purpose of the present study was to assess the association between visual fields, categorised by traditional criteria, and concomitant Vistech contrast sensitivity measurements.

Table 1 Criteria used for interpretation of visual fields

1 Normal, peripheral	No defect seen
2 Borderline peripheral	
(a) Nasal hemianopic offset	10° or greater offset nasal to vertical midline
(b) Peripheral constriction, temporally or vertically	Isopter inside 50° temporally 40° inferiorly, or 30° superiorly
3 Defect, peripheral	
(a) Nasal step	10° or greater offset above or below the horizontal raphe, nasally
(b) Peripheral constriction, nasally	Isopter inside 30°, nasally
(c) Temporal sector defect	20° or greater defect toward blind spot in temporal isoptre
(d) Temporal hemianopic offset	10° or greater offset temporal to vertical midline
4 Normal, central	zero or one defect* point
5 Borderline, central	
(a) Paracentral depression	2 to 5 non-contiguous defects in Bjerrum area
(b) Enlarged blind spot	2 to 5 contiguous defects next to blind spot (not all in Bjerrum area)
(c) Peripheral depression	3 or more contiguous defects outside Bjerrum area
(d) Diffuse depression	All points equally depressed
6 Defect, central	
(a) Paracentral scotoma	2 to 5 contiguous defects in Bjerrum area
(b) Seidel scotoma	2 to 5 contiguous defects next to blind spot in Bjerrum area
(c) Arcuate scotoma	6 or more contiguous defects in Bjerrum area (single or double)
(d) Nasal step	2 or more defects above or below horizontal raphe in nasal periphery
(e) Temporal sector defect	6 or more contiguous defects temporal to blind spot

*Defect refers to depression of 6 dB or more below age-related retinal threshold for point being tested.

Table 2 Comparison of Vistech line scores A through E (1·5, 3, 6, 12, and 18 cycles per degree) for normal, suspect and defect groups*

	Normal	Suspect	Defect
Number	16	13	31
Line score A	5·1 (0·2)	5·0 (0·2)	5·0 (1·0)
Line score B	5·5 (0·3)	5·7 (0·2)	5·4 (0·1)
Line score C	4·5 (0·4)	4·8 (0·3)	4·3 (0·3)
Line score D	3·3 (0·6)	3·8 (0·5)	3·5 (0·3)
Line score E	2·8 (0·5)	2·8 (0·5)	2·4 (0·3)

*Standard errors are in parentheses. No significant differences between the three groups were found.

Materials and methods

The study population consisted of subjects who were being followed up in the Glaucoma Clinic of Duke University Eye Center for manifest glaucoma or a suspicion of glaucoma on the basis of intraocular pressure elevation. Visual fields were assessed with the Fieldmaster 5000 (static/kinetic perimeter; Bausch and Lomb, Rochester, NY), and contrast sensitivity was measured under conditions of constant illumination with Vistech sine wave gratings (Vistech Consultants, Dayton, Ohio). The Fieldmaster 5000, the details of which have been previously described,[10] is a fully automated perimeter which measures the peripheral field with a kinetic target and the central 30° with static targets. In the present

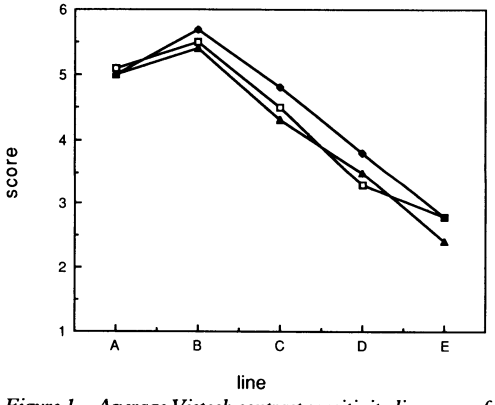

Figure 1 Average Vistech contrast sensitivity line scores for normal, suspect, and defect groups. Lines A-E correspond to five static spacial frequencies: 1·5, 3, 6, 12, and 18 cycles per degree. Normal □. Suspect ◆. Defect ▲.

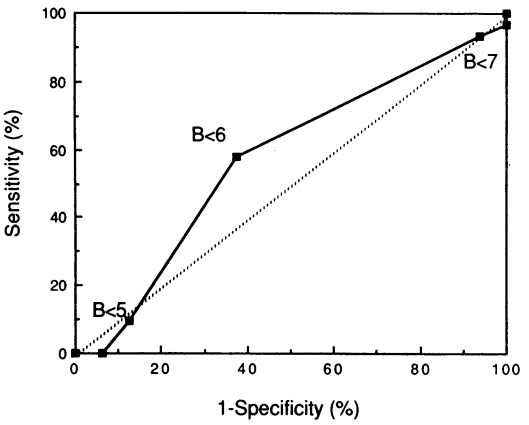

Figure 2 Receiver operator characteristic (ROC) curve showing Vistech line B score (3 cycles per degree) as a detector of glaucomatous field loss. Criteria for abnormal classification are indicated along the curve.

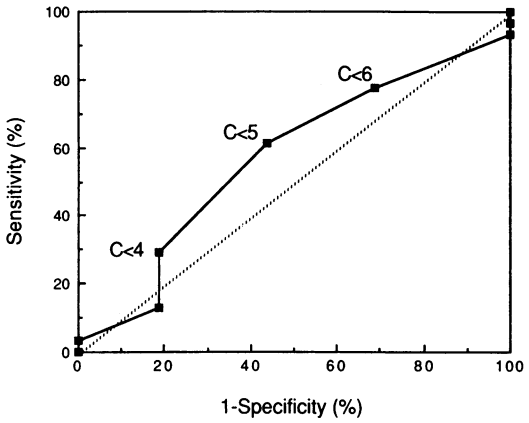

Figure 3 ROC curve showing Vistech line C score (6 cycles per degree) as a detector of glaucomatous field loss. Criteria for abnormal classification are indicated along the curve.

study the central, static points were first tested with a supratheshold stimulus, followed by full thresholding of all points missed on the initial presentation, and the peripheral field was measured with a single isopter. The Vistech wall chart system provides a rapid score on an integral scale from 0 to 8, corresponding to the number of patterns correctly identified, for each of five static spatial frequencies. These frequencies, 1·5, 3, 6, 12, and 18 cycles per degree, are defined as lines A through E respectively.

Visual fields were evaluated in masked fashion by glaucoma clinicians (MBS and WCS) into defect (D), suspect (S), and normal (N) categories on the basis of detailed subjective criteria which involved pass/fail grading into a total of 16 separate subcategories (Table 1). Patients assigned to group D included those with definitive glaucomatous changes or >2 borderline abnormalities. Group N included those subjects with no abnormal findings, and group S included the remainder. When both fields from a single subject fell into the same rating group, one was randomly selected for analysis. Otherwise the eye with the greater defect was included, so that only one eye from each subject was considered. All eyes under study had visual acuities of 20/40 or better. Differences between the two groups were analysed by the unpaired *t* test. Sensitivites and specificities were determined for a variety of criteria, with Vistech scores being used as detectors of glaucomatous field loss.

Results

Sixty patients were included in the study, 31 in group D, 13 in group S, and 16 in group N. The mean ages for the D, S, and N subgroups were: 54 (range 25–76), 55 (range 29–78), and 53 (range 25–72) respectively. Table 2 and Fig 1 show the average contrast sensitivity scores for the three groups. Mean scores of the D, S, and N field groups did not differ significantly at any of the five spatial frequencies provided on the test charts. Complex algorithms looking for midrange deficit – that is, average (A, B) −C; A−average (B, C); A+D−B; A+D−C; A+B−(C+D); A+D−(B+C); B−C; A−C; A−B) – also failed to yield any significant mean differences between the groups. Diagnostic sensitivity/specificity (receiver operator characteristic; ROC) curves relating Vistech contrast sensitivity findings to perimetry groups N and D are shown in Figs 2 and 3 for lines B and C (3 and 6 cycles per degree). These data suggest that Vistech contrast sensitivity scores of B<6 or C<5 offer the greatest combination of diagnostic sensitivity and specificity. A looser cutoff point (B<7 or C<6) would include many normal subjects, while a more rigid cutoff limit (B<5 or C<4) would miss many glaucomas. Vistech results at or below the latter levels, however, would provide a reasonable indication of pathology, with false positive rates of <20%. Table 3 includes sensitivity/specificity values for classification criteria involving lines B and C. Three criteria produce sensitivity and specificity values concomitantly greater than 50%: B<6, C<5, and average (B, C) <5. None produced sensitivity and specificity values concomitantly exceeding 60%.

Table 3 Sensitivity and specificity values using Vistech line scores B (3 cycles per degree) and C (6 cycles per degree) as detectors of glaucomatous field loss

Abnormal classification	*Sensitivity*	*Specificity*
B<6	58·1%	62·5%
C<5	61·3%	56·3%
C<5 and B<6	48·4%	68·8%
C<5 or B<6	71·0%	50·0%
average (B and C) <5	68·8%	51·6%

Discussion

The sensitivity/specificity values obtained in the present study for contrast sensitivity scores are low, with the best association with subjectively classified visual fields seen at 3 and 6 cycles per

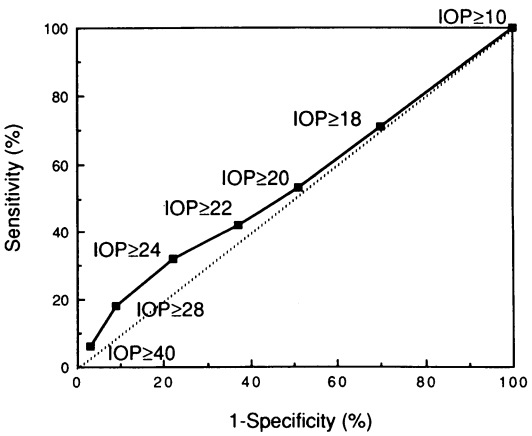

Figure 4 ROC curve showing intraocular pressure (IOP in mmHg) as a detector of glaucomatous field loss. Criteria for abnormal classification are indicated along the curve. Adapted from Hill[11] based on data from Daubs and Crick.[12]

degree. These sensitivity/specificity curves are nevertheless more definitive than published associations between intraocular pressure and visual fields (Figure 4).[11 12] The findings presented here are consistent with those of Adams *et al*[13] who found that mean contrast sensitivities of glaucomatous subjects were significantly lower ($p<0.02$) at all frequencies but were within one standard deviation of those of the normal controls.

While measurements of contrast sensitivity involve the perimacular region of the retina, classic glaucomatous field loss characteristically occurs more peripherally. Recent work in this laboratory (UW-Madison) reveals a significant association ($p<0.05$) between the bilateral asymmetry of Vistech contrast sensitivity scores (at 3 and 6 cycles per degree) and the asymmetry of visual field indices obtained by Humphrey automated perimetry in glaucomatous patients.[14] In the present study, however, asymmetry of Vistech scores between the two eyes did not correlate significantly with the presence of a visual field defect in either eye. Together these studies demonstrate the importance of distinguishing between correlation of contrast sensitivity with glaucomatous change and its actual diagnostic utility.

The use of subjective visual field assessments as the standard for comparison in this study does not preclude the possibility that the Vistech system may elicit some early glaucomatous changes to which perimetry remains insensitive. If so, however, such static contrast changes must occur frequently among normal individuals as well. Thresholding only defective areas in the present study may have slightly reduced the sensitivity of the visual field testing, though a study using the Humphrey Analyzer has revealed differences in subjective interpretation between paired full thresholding and quantification of defects in only 18 of 104 fields.[15] It is possible that modifications of existing contrast sensitivity testing methods may increase their diagnostic utility for glaucoma detection. Such adaptations might include the use of temporal modulation and/or opponent colour contrast paradigms within a rapid and clinically amenable testing format.[13 16-27]

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