Topographic Comparison of the Visual Function on Multifocal Visual Evoked Potentials with Optic Nerve Structure on Heidelberg Retinal Tomography

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Purpose: The authors' objective was to compare the visual field obtained using multifocal visual evoked potential (mfVEP) testing with the optic nerve parameters of Heidelberg retinal tomography (HRT; Heidelberg Engineering, Heidelberg, Germany; software version 2.01) in primary open-angle glaucoma (POAG) patients and normal controls and to determine which parameters correlate with visual function.

Design: Cross-sectional study.

Participants: Eighty-one eyes of 42 adult POAG patients and normal controls between the ages of 40 and 80 years, of which 35 patients (67 eyes; mean age±standard deviation [SD], 68±10 years) had POAG, and 7 individuals who served as normal controls (14 eyes; mean age±SD, 61±10 years) were included.

Methods: A monocular mfVEP test, the AccuMap (Opera software version 2.0; ObjectiVision Pty. Ltd., Sydney, Australia), with a 58-sector pattern-reversal dart board array was recorded in both eyes per patient. These patients underwent the HRT 2 and mfVEP tests within 3 months of each other.

Main Outcome Measures: Amplitudes in the superior hemisphere of the mfVEP trace were compared with the HRT parameters in the inferior hemisphere of the HRT and vice versa using mixed effects regression models.

Results: Amplitudes on the superior hemisphere of the mfVEP recordings showed a significant direct correlation with rim-to-disc area ratio ($P = 0.0037$), rim volume ($P = 0.0421$), and mean retinal nerve fiber layer (RNFL) thickness ($P = 0.0016$) and a significant inverse correlation with cup area ($P = 0.0009$) and cup-to-disc area ratio ($P = 0.0037$) in the inferior hemisphere of the HRT results. Amplitudes on the inferior hemisphere showed a significant direct correlation with rim-to-disc area ratio ($P = 0.036$) and a significant inverse correlation with cup area ($P = 0.0007$), cup-to-disc area ratio ($P = 0.036$), cup volume ($P<0.0001$), and mean cup depth ($P = 0.0012$) in the superior hemisphere of the HRT results.

Conclusions: Results from mfVEP and HRT showed correlation between visual function and optic nerve structure. *Ophthalmology 2008;115:440–446 © 2008 by the American Academy of Ophthalmology.*

Heidelberg retinal tomography (HRT; Heidelberg Engineering, Heidelberg, Germany) and multifocal visual evoked potential (mfVEP) testing are objective techniques that have been introduced recently to diagnose and observe glaucoma.

Heidelberg retinal tomography, which provides useful information about the morphologic features of the optic nerve head (ONH), has been shown to be able to discriminate between control subjects and patients with early glaucoma when cup area and cup-to-disc area ratios are studied.[1] This device uses a confocal laser to generate 3-dimensional images and quantitative data of the ONH. The HRT has been found to have a sensitivity and specificity in the range of 70% to 93% and 65% to 100% in different studies.[1–6]

The AccuMap (Opera software version 2.0; ObjectiVision Pty. Ltd., Sydney, Australia) is an mfVEP system that objectively measures visual field loss in glaucoma.[7,8] It is an electrophysiologic technique based on a pseudorandom patterned stimulus in 58 sectors of the visual field (eccentricity, ≤32°). The visual evoked responses are recorded from bipolar occipital electrodes. Goldberg et al[9] reported a strong correlation between visual field loss on subjective perimetry and amplitudes of waves on the AccuMap, the sensitivity and specificity of the mfVEP test being more

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than 90%. The same group also reported this test to be useful clinically to distinguish glaucoma from variable subjective field results.[10]

It has been suggested that 40% of neuroretinal rim loss is necessary before a defect appears on Humphrey visual field (HVF) perimetry.[11] Recent studies have compared sensitivity and specificity of the HRT and mfVEP in glaucoma with the HVF and have found that the HVF and mfVEP correlate well with each other, but the correlation with HRT was limited (59%–78%).[12] The purpose of the present study was to correlate topographically the visual function as measured by amplitudes of waves on the mfVEP with structure of the ONH on the HRT in patients who have established primary open-angle glaucoma (POAG) and in normal controls and to determine which parameters on the HRT correlate with visual function.

Patients and Methods

This cross-sectional study included 81 eyes of 42 POAG patients and normal controls at University of California San Francisco School of Medicine after appropriate institutional review board approval was obtained. Thirty-five POAG patients (67 eyes; mean age±standard deviation [SD], 68±10 years) and 7 normal controls (14 eyes; mean age mean age±SD, 61±10 years), between 40 and 80 years of age, were recruited for inclusion into this cross-sectional study between September 2005 and September 2006. The control group consisted of spouses of the patients (with no family history of glaucoma) and volunteers from the general community. Individuals were included in the study if they had visual acuity better than 20/40; refraction better than ±6 diopters (D); no history of diabetes, cataract, or ocular disease other than glaucoma; and no previous intraocular surgery. All individuals were between 40 and 80 years of age. The patients and normal controls underwent slit-lamp examination, indirect ophthalmoscopy, HRT, Humphrey automated perimetry, and mfVEP as part of their glaucoma evaluation. Informed consent was obtained from all participants to include the data in this study, and the study followed the principles of the Declaration of Helsinki.

The diagnosis of glaucoma in the study group required a confirmed visual field defect (reproducible on 2 or more occasions, excluding that of the initial visit) on 24-2 HVF testing and a glaucomatous optic disc with typical loss of neuroretinal rim as judged by slit-lamp biomicroscopy by 2 glaucoma specialists (cup-to-disc ratio, >0.7; intereye cup asymmetry, >0.2; or neuroretinal rim notching, focal thinning, disc hemorrhage, or vertical elongation of the optic cup). Intraocular pressure was not used as a criterion for this group. Visual field defects were determined based on the pattern deviation plot on the HVF. A minimum scotoma required a cluster of 3 or more abnormal points (of which at least 2 were depressed by $P<0.005$ on the pattern deviation probability plot), which could not cross the horizontal meridian, and points immediately above and below the blind spot could not qualify as part of the scotoma. Peripheral rim points could qualify as part of the overall scotoma, but at least 2 of the points that qualified as the nucleus could not be location on the rim. All eyes that qualified for inclusion in the study were considered.

The normal controls were included if they had normal optic disc morphologic features and a cup-to-disc ratio of less than 0.6, the ability to perform a reliable Humphrey 24-2 Swedish interactive threshold algorithm standard visual field test (reliability parameters, <33%), with normal glaucoma hemifield test results and a normal mean deviation and pattern standard deviation ($P>0.05$).

All study participants underwent HRT tests (15°×15°) obtained through undilated eyes within 3 months of the mfVEP by 1 of 2 technicians who had more than 10 years experience with the technique. They were reviewed by an ophthalmologist for correct placement of the contour line, and only recordings that had topographic standard deviation of less than 30 μm were included. Both the technician and the ophthalmologist were masked to the patient diagnosis. All recordings were analyzed using HRT software version 2.0.1, with Moorfields regression analysis used for classification of eyes as normal, borderline, or abnormal.

The monocular mfVEP with a 58-sector pattern-reversal dart board array was recorded in both eyes per patient with the AccuMap and was performed by a single technician (OSP) who was masked to the patient diagnosis. The AccuMap procedure has been described in detail previously by Graham et al,[10] Quigley et al,[11] and Klistorner and Graham,[13] but we summarize the test procedure and equipment used herein. The test was carried out in a dimly lit room. The visual stimulus was generated on a 21-inch high-resolution display screen with vertical refresh rate of 75 Hz. Luminance of the white check was 146 cd/m^2 and luminance of the black check was 1.1 cd/m^2 (Michelson contrast, 99%). Background luminance of the screen was 73.5 cd/m^2. All subjects were refracted optimally for near vision, and the pupils were not dilated. They were seated 30 cm from the screen. Four gold cup electrodes were used for bipolar recording: 2 electrodes positioned 4 cm on either side of the inion and 2 electrodes in the midline, 2.5 cm above and 4.5 cm below the inion, respectively. A custom-designed electrode cross was used to keep electrodes in place. We made certain that the electrodes were placed in a similar position for both tests by measuring the sagittal distance to the nasion.

Electrical signals were recorded along 4 channels as follows: the difference between superior and inferior electrodes; the difference between left and right electrodes; obliquely, the difference between left and inferior electrodes; and obliquely, the difference between right and inferior electrodes. A ground electrode was placed on an ear lobe. The stimulus consisted of a cortically scaled dart board pattern of 58 segments (eccentricity up to 24° with nasal step up to 32°) with a central fixation target. The fixation targets used were numbers between 1 and 10. Each segment contained a 4×4 grid of black and white checks (scaled proportional to segment size), which reverse patterns according to pseudorandom sequence (4096 elements, 54 seconds long). A family of sequences was used to drive all the 58 segments simultaneously. The technique permits computation of response evoked by the sequence stimulation with the sequence itself. At the end of the run (i.e., 54 seconds), a different sequence was assigned to the segment for the next run. In most patients, 10 runs (up to a maximum of 12) were needed to achieve acceptable test results.

The visual evoked responses were amplified 100 000 times (sampling rate, 512 Hz; bandpass filtered, 1–20 Hz). Opera software (ObjectiVision Pty. Ltd., Sydney, Australia) correlated the electrical responses with the stimulus reversal and attributed the signal to the segment. Noise is estimated automatically by the inbuilt Opera software, which can segregate the signal from noise based on the amplitudes, duration, and latencies of the waves during each run, and hence the signal-to-noise ratio (SNR) for the test is calculated. The noise and SNR for the entire eye analysis is calculated by averaging the SNR in the individual runs. The electrical responses were averaged over multiple reversals to improve the SNR of the segment. Patients having noise levels of more than 30% were excluded from the analyses.

The AccuMap severity index (ASI) was calculated using a proprietary discriminant function (ObjectiVision), which was dependent on the size of the scotoma, its depth, and its presence on

Table 1. Humphrey Visual Field Analyses in the Study Population

Mean Humphrey Visual Field Values	Glaucoma Group (67 Eyes)	Normal Control Group (14 Eyes)
Mean deviation (dB)	–6.2 ± 0.8	0.7 ± 0.4
Pattern standard deviation (dB)	0.9 ± 0.2	–0.5 ± 0.2

Table 3. Heidelberg Retinal Tomography Results in the Study Population Based on Moorfields Regression Analysis

Heidelberg Retinal Tomography Results	Glaucoma Group (n = 67)	Normal Control Group (n = 14)
Within normal limits	5 (7%)	11 (79%)
Borderline	4 (6%)	1
Outside normal limits	58 (87%)	2
Total	67	14

the asymmetry plot. Scores of 0 to 19 were classified as normal, and scores of 20 or more were classified as abnormal.

Participants who were selected prospectively for inclusion underwent both HRT and mfVEP analysis. The results of these 2 tests were exported directly from the instrument onto an Excel spreadsheet (Microsoft, Redmond, WA), and the data obtained were used in the analyses. Data from the AccuMap was obtained in the form of the ASI and individual amplitudes in each of the 58 sectors. The HRT data consisted of ONH parameters in 6 sectors.

Statistical Analyses and Main Outcome Measures

Anatomic relationships between Humphrey 24-2 test points and regions of the ONH previously were reported.[14] The supertemporal and supranasal sectors on the HRT were combined (values added) to form the value of the superior hemisphere for that parameter on the HRT. Similarly, the inferotemporal and inferonasal sectors on the HRT were added to form the value of the inferior hemisphere for that parameter for each patient on the HRT. The amplitudes on the superior 29 sectors on the mfVEP trace were added to form the total amplitude of the superior hemisphere on the mfVEP for each patient, and similarly, amplitudes were calculated for the inferior hemisphere for each patient. Because visual field defects and optic nerve structure in glaucoma generally obey a horizontal meridian, the authors tried to correlate the amplitudes in the superior hemisphere of the mfVEP trace with the parameters on the inferior sector of the ONH on HRT and vice versa using mixed effects regression models. This method for evaluating correspondence between structure and function was chosen in recognition that glaucoma generally obeys the horizontal meridian; the mixed effects regression analyses were used because they accommodate for clusters of multiple responses from both eyes in each patient. The intention was to minimize the effect of multiple related parameters and the effect of using 2 eyes of the same patient. This method of data analysis takes complex sampling designs into account.

Table 2. Multifocal Visual Evoked Potential Responses in the Study Population

Multifocal Visual Evoked Potential Responses (AccuMap Severity Index/Amplitude Score)	Glaucoma Group (n = 67)	Normal Control Group (n = 14)
ASI <20 (within normal limits)	3 (4%)	11 (79%)
ASI ≥20 (outside normal limits)	64 (96%)	3
Total	67	14
Mean ASI	107 ± 18	13 ± 4
Mean amplitude (nV)	290 ± 36	380 ± 25

ASI = AccuMap severity index.

Results

The mean values of mean deviation and pattern standard deviation on HVF testing in the glaucoma and the normal control groups, respectively, are shown in Table 1. Of the 35 POAG patients (mean age±SD, 68±10 years), 3 eyes were excluded from the analysis because they did not meet the inclusion criteria. Both eyes of the 7 normal control subjects were included (14 eyes; mean age±SD, 61±10 years).

The mfVEP responses in the study population are shown in Table 2. Of the 67 eyes (35 patients) diagnosed with glaucoma, 64 had an ASI outside normal limits (96%) and the remaining 3 had values that were within normal limits (4%). Three eyes of the 7 normal controls had an ASI outside normal limits, and the remaining 11 eyes were within normal limits (79%). The difference in ASI and amplitudes between the 2 groups was statistically significant.

Table 3 shows the Moorfields regression analyses results in the 2 groups on HRT. The HRT was able to detect optic nerve abnormalities in 62 (93%) of 67 eyes in the glaucoma group and was within normal limits in 5 eyes (7%). The control group had normal values in 11 (79%) of the 14 eyes and was borderline or abnormal in 3 eyes (21%).

Table 4 demonstrates the agreement between the HRT and mfVEP test results in the 2 groups. In the glaucoma group, the 2 tests agreed in 57 eyes (85%). For 2 eyes, the HRT results were abnormal and the mfVEP results were normal. In 8 eyes, the mfVEP results were abnormal and the HRT results were normal. In the normal control group, the results from the 2 tests agreed in 12 eyes (86%). One eye had abnormal HRT results with normal mfVEP results, and 1 eye had abnormal mfVEP results and normal HRT results.

Mixed effects regression analyses were used to predict amplitudes of the mfVEP responses from HRT parameters in the corresponding opposite hemisphere and hence to correlate the struc-

Table 4. Agreement between Heidelberg Retinal Tomograph and Multifocal Visual Evoked Potential Results in the 2 Groups

	Glaucoma Group (n = 67)	Normal Control Group (n = 14)
mfVEP and HRT results abnormal	56 (84%)	2
mfVEP and HRT results normal	1 (1%)	10 (72%)
mfVEP results normal and HRT results abnormal	2 (3%)	1
mfVEP results abnormal and HRT results normal	8 (12%)	1
Total	67	14

HRT = Heidelberg Retinal Tomograph; mfVEP = multifocal visual evoked potential.

Table 5. Mixed Effects Regression Model Predicting the Amplitudes in the Superior Hemisphere of the Multifocal Visual Evoked Potential Recordings from the Heidelberg Retinal Tomography Parameters in the Inferior Hemisphere in the Study Population (Glaucoma Group plus Normal Controls)

Heidelberg Retinal Tomograph Parameters (Inferior Hemisphere)	Slope Estimate	Lower 95% Confidence Interval	Upper 95% Confidence Interval	*P* Value	Right Eye Amplitude in the Superior Hemisphere (Spearman Rank Correlation)	Left Eye Amplitude in Superior Hemisphere (Spearman Rank Correlation)
Optic disc area	–72	–130	–15	**0.02**	–0.3	–0.2
Optic cup area	–97	–151	–43	**<0.001**	–0.4	–0.2
Optic rim area	32	–29	92	0.3	0.05	0.02
Optic cup-to-disc area ratio	–34	–56	–12	**0.004**	–0.3	–0.1
Optic rim-to-disc area ratio	34	12	56	**0.004**	0.3	0.1
Optic cup volume	–215	–338	–93	**0.001**	–0.4	–0.1
Optic rim volume	146	6	286	**0.04**	0.2	0.3
Mean cup depth	–29	–67	9	0.1	–0.1	0.19
Maximum cup depth	–18	–38	1	0.07	–0.003	–0.002
Height variation contour	37	–39	112	0.3	0.08	0.2
Cup shape measure	6	36	25	0.7	–0.2	–0.03
Mean RNFL thickness	52	21	82	**0.002**	0.4	0.3

RNFL = retinal nerve fiber layer thickness.
Boldface, statistically significant using 95% confidence intervals. Also shown are the correlations between the amplitudes in the superior hemispheres of the left and right eyes separately and the Heidelberg retina tomography parameters in the inferior hemisphere.

ture-function relationship in the entire study population. The 2 groups were combined to study the relationship between optic nerve structure and visual function regardless of patient diagnosis.

In the glaucoma group, amplitudes on the superior hemisphere of the mfVEP recordings showed a significant direct correlation with rim-to-disc area ratio ($P = 0.0037$), rim volume ($P = 0.0421$), and mean retinal nerve fiber layer (RNFL) thickness ($P = 0.0016$) and a significant inverse correlation with cup area ($P = 0.0009$) and cup-to-disc area ratio ($P = 0.0037$) in the inferior hemisphere of the HRT. Amplitudes on the inferior hemisphere showed a significant direct correlation with rim-to-disc area ratio ($P = 0.036$) and a significant inverse correlation with cup area ($P = 0.0007$), cup-to-disc area ratio ($P = 0.036$), cup volume ($P<0.0001$), and mean cup depth ($P = 0.0012$) in the superior hemisphere of the HRT. Tables 5 and 6 show the prediction of the visual evoked potential measurements from the HRT measurements. For example, in Table 5, a slope estimate of –72.3 means that if the optic disc area increases by 1 mm^2, then the VEP amplitude in the superior hemisphere goes down by 72.3 nV.

Noise levels on an average were 20% in the glaucoma group and 14% in the normal control group. We studied the difference between the noise levels in the 2 groups and found them to be statistically nonsignificant, at a *P* level of 0.15.

Even though there was a significant association between structure and function in the groups, there were some isolated examples of poor correspondence between structure and function, one of which is shown in Figure 1.

Discussion

Variability of subjective test results poses a significant problem in glaucoma diagnosis and follow-up. Hence, objective tests have been sought to improve reliability of glaucoma diagnosis and progression detection. A recent study[12] compared the same objective tests (AccuMap and HRT) and found the mfVEP sensitivity and specificity to be 93% and 96%, respectively, based on the presence of scotomas that corresponded to those on HVF. The HRT sensitivity and specificity were 79% and 92%, respectively, based on Moorfields regression analysis in the study, and comparison of ONH structural abnormality with corresponding areas of field defects on HVF and mfVEP showed poor to moderate agreement in that study. The AccuMap severity index was compared with some of the structural parameters on HRT (such as optic cup area, optic rim area, cup-to-disc area ratio, etc.). The objective tests of optic nerve function (mfVEP) and structure (HRT) were found to detect glaucomatous damage, but with limited correlation in their study. After dividing the mfVEP into 3 zones, the agreement between HRT and mfVEP (κ statistic) was found to vary from poor in the central zone (0.07; 95% confidence interval, −0.21 to 0.35) to moderate in the remaining 2 zones (superior zone, 0.60; 95% confidence interval, 0.4–0.79; inferior zone, 0.41; 95% confidence interval, 0.18–0.64). Although the authors mention that they performed a topographic correlation between HRT and mfVEP, the authors found no data in this study that spatially compared optic nerve structure with actual amplitudes of mfVEP waves (visual function) in the radially opposite hemisphere of the mfVEP trace to determine a structure-function relation.

This study had 2 objectives: first, to correlate spatially the optic nerve structure with mfVEP amplitudes (visual function) with 2 objective tests for glaucoma diagnosis (HRT and mfVEP); and second, to determine which parameters of the ONH on HRT correlate with visual function, and

Table 6. Mixed Effects Regression Model Predicting the Amplitudes in the Inferior Hemisphere of the Multifocal Visual Evoked Potential Recordings from the Heidelberg Retinal Tomography Parameters in the Superior Hemisphere in the Study Population (Glaucoma Group plus Normal Controls)

Heidelberg Retinal Tomography Parameters (Superior Hemisphere)	Slope Estimate	Lower 95% Confidence Interval	Upper 95% Confidence Interval	P Value	Right Eye Amplitude in the Inferior Hemisphere (Spearman Rank Correlation)	Left Eye Amplitude in the Inferior Hemisphere (Spearman Rank Correlation)
Optic disc area	–99	–170	–28	**0.007**	–0.06	–0.1
Optic cup area	–134	–208	–60	**0.001**	–0.04	–0.09
Optic rim area	16	–72	105	0.7	0.05	0.03
Optic cup-to-disc area ratio	–34	–65	–2	**0.04**	–0.05	–0.01
Optic rim-to-disc area ratio	34	2	65	**0.04**	0.05	0.01
Optic cup volume	–225	–318	–132	**<0.001**	–0.1	–0.04
Optic rim volume	22	–156	200	0.8	0.06	0.1
Mean cup depth	–56	–89	–24	**0.001**	–0.04	–0.2
Maximum cup depth	–17	–34	0.6	0.05	0.03	0.1
Height variation contour	–27	–84	30	0.3	0.06	0.2
Cup shape measure	–26	–60	8	0.1	–0.1	–0.1
Mean RNFL thickness	25	–14	65	0.2	0.1	0.1

RNFL = retinal nerve fiber layer.
Boldface, statistically significant using 95% confidence intervals. Also shown are the correlations between the amplitudes in the inferior hemispheres of the left and right eyes separately and the Heidelberg retina tomography parameters in the superior hemisphere.

hence to provide physicians with an idea about abnormalities in which HRT parameters are more likely to indicate glaucoma. We found a good correlation between amplitudes on the mfVEP with most parameters on the corresponding opposite hemisphere of the HRT. This indicates that structure of the ONH correlates well with visual function in POAG patients and normal controls. Of the parameters studied, the optic cup area, cup volume, cup-to-disc area ratio, and mean cup depth showed significant negative associations with amplitudes of waves on the corresponding opposite hemispheres of the mfVEP trace. The optic rim area, rim-to-disc area ratio, rim volume, and mean RNFL thickness showed a direct correlation with amplitudes of waves on the mfVEP. These results confirm the optic nerve structure-visual field function relationship in POAG, as measured by these 2 objective tests.

Signal-to-noise ratio is an important variable during mfVEP testing, and recordings with high noise levels should be interpreted with caution. Although the 2 groups did not differ significantly in noise levels, the average noise levels in the 2 groups were high (20% and 14% in POAG and normal controls, respectively).

Despite the favorable correlation between HRT and mfVEP responses, there were some striking individual examples of poor correspondence between optic nerve structure and visual function, which may be attributed to variations in peripapillary nerve fiber and disc anatomy in healthy individuals. This population seems to be fairly representative of target adult populations with glaucoma because of their age distribution, the severity of the disease process, and the exclusion of other causes of visual field defects by a complete ophthalmic examination and ancillary testing.

In a recent study, a significant correlation was found between several optic disc parameters and the global indices of HVF. Rim area, rim volume, cup-to-disc area ratio, rim-to-disc area ratio, cup shape measurement, and RNFL cross-sectional area showed the strongest correlation,[15] whereas another recent study showed that the highest specificity (80%) and sensitivity (74%) in glaucoma were cup volume, rim volume, cup shape measure, and height variation contour parameters.[16] In the study, the following HRT parameters correlated significantly with visual function: optic cup area, disc area, cup-to-disc ratio, rim-to-disc ratio, cup volume, rim volume (inferior), and mean RNFL thickness (inferior).

This study substantiates the theory that there is a relationship between optic nerve structural abnormality and failure of the neural pathways to transmit information to the cortex. Either of these diagnostic tests may produce normal results in the presence of glaucoma or false-positive results in the absence of glaucoma. Hence, performing more than 1 test for the diagnosis and management of this disease is advisable. The choice of objective tests in this study reduces the chance of having erroneous results caused by the subjective variability of HVF testing. However, a limitation of this study is the fact that individuals suspected of having glaucoma (ocular hypertensives and patients with suspicious optic discs) were excluded from the analysis. This was done so as to include patients having established visual field loss (the glaucoma group) or no field defects (normal control group). This enabled the authors to correlate reliably the findings of mfVEP with those of HVF testing. Also, it would have been useful to include a larger number of normal controls in the study. Future studies targeted toward comparison of optic nerve structure with visual function in

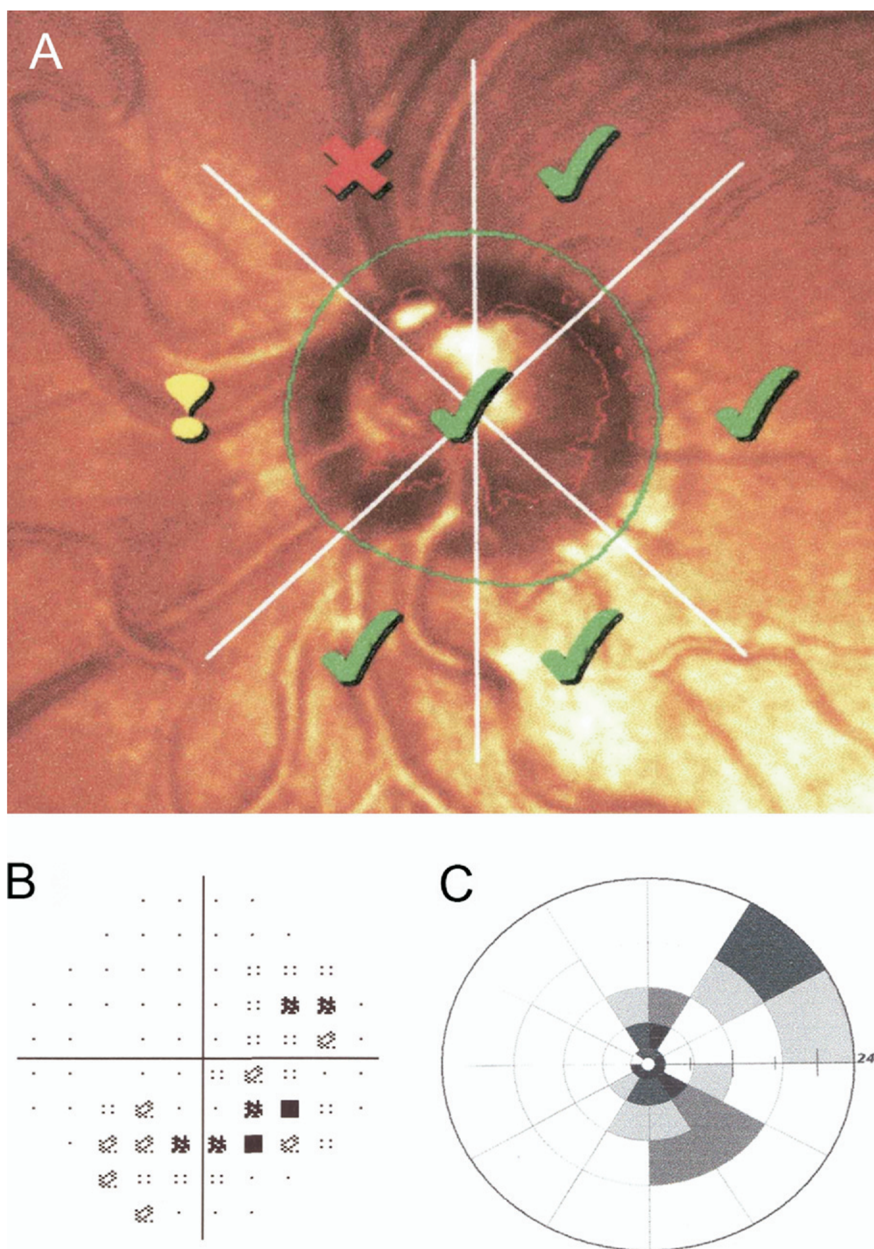

Figure 1. Example of poor correspondence between optic nerve head structure and visual function. This patient has (**A**) abnormal Moorfields regression analysis results on the nasal and superior sectors of the Heidelberg retinal tomography results in the left eye and (**B**) a visual field defect in the nasal and inferior sector on Humphrey visual field testing. **C**, However, the defects on the AccuMap corresponded with Humphrey testing results.

ocular hypertensives and glaucoma suspects would be useful in furthering our understanding of the structure-function relationship in glaucoma.

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