Clinical Clues to Predict the Presence of Parafoveal Scotoma on Humphrey 10-2 Visual Field Using a Humphrey 24-2 Visual Field

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• PURPOSE: To investigate characteristics related to the presence of parafoveal scotoma on Humphrey 10-2 visual field (VF) in early glaucoma patients.
• DESIGN: Prospective, cross-sectional study.
• METHODS: PARTICIPANTS: Ninety-one eyes from 91 patients with glaucomatous optic neuropathy were prospectively tested with a 10-2 VF test. OBSERVATION PROCEDURES: Glaucoma patients were classified into eyes with or without parafoveal scotoma on 10-2 VF based on pattern deviation plot. The central 10 degree region of Humphrey 24-2 VF test comprised 12 points and any abnormal VF points depressed $<5\%$, $<2\%$, $<1\%$, or $<0.5\%$ from the normal database on pattern deviation plot were analyzed. Various factors related to the presence of parafoveal scotoma on 10-2 VF were analyzed. MAIN OUTCOME MEASURES: Abnormal 24-2 VF points, macular ganglion cell–inner plexiform layer thickness.
• RESULTS: The presence of abnormal 24-2 VF points $<0.5\%$ was significantly different between eyes with and without parafoveal scotoma on 10-2 VF ($P < .01$). The minimum macular ganglion cell–inner plexiform layer thickness ($P = .04$), any central 12 points depressed $<0.5\%$ on 24-2 VF ($P < .01$), and any central 12 points depressed $<5\%$ on 24-2 VF that spatially corresponds to macular ganglion cell–inner plexiform layer thinning ($P < 0.01$) were related factors to the presence of parafoveal scotoma on 10-2 VF.
• CONCLUSIONS: Glaucomatous eyes with any abnormal 24-2 VF points on the central 10 degree region that are depressed $<0.5\%$ or $<5\%$ that correlates to macular ganglion cell–inner plexiform layer thinning should receive attention and be further evaluated with a 10-2 VF test. (Am J Ophthalmol 2016;161:150–159.

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GLAUCOMATOUS VISUAL FIELD (VF) DAMAGE USUally initiates in the Bjerrum area, and the central VF tends to be preserved until the advanced stage of glaucoma.[1] However, a recent investigation showed that macular involvement and parafoveal VF damage can occur in early glaucoma.[2,3] Furthermore, the VF test most commonly used to assess glaucomatous functional loss, the central 24-2 threshold test, is reported to miss damage to the macula.[4–6] More than 30% of the retinal ganglion cells reside in the central VF region, and only 4 points from the central 24-2 threshold test fall within this region. The importance of using central 10-2 tests, with 68 points spaced 2 degrees apart in the same region, has been proposed from several studies investigating this issue. From investigations of parafoveal scotomas using the 10-2 test, previous reports have characterized the detection rate, progression pattern, and progression rate of parafoveal scotomas detected using these tests.[4,7,8] Nevertheless, it is difficult to decide whether central 10-2 tests are needed for a particular patient in clinical practice. It is time-consuming and costly to evaluate all patients using both the 24-2 and 10-2 tests. However, knowing the importance of using the 10-2 test to not miss an undetected parafoveal scotoma on a 24-2 test makes clinicians conflicting. Therefore, we aimed to elucidate some clues to guide clinicians on when to perform a 10-2 VF test to evaluate parafoveal scotomas in place of, or combined with, 24-2 VF tests.

In this study, we prospectively performed both 10-2 and 24-2 VF tests in a group of patients with glaucomatous optic discs and localized retinal nerve fiber layer (RNFL) defects. The VF states of these patients ranged from normal to mild glaucomatous defects (mean deviation [MD] ≤ -6 dB) on 24-2 VF tests. Characteristics and factors related to the presence of parafoveal scotomas on 10-2 VF tests were evaluated.

METHODS

IN THIS PROSPECTIVE CROSS-SECTIONAL STUDY, 92 EYES OF 92 glaucoma patients were scheduled to undergo both 24-2 and 10-2 VF tests (Carl Zeiss Meditec, Dublin, California, USA) at the glaucoma clinic of Seoul St Mary's Hospital between November 2012 and August 2013.

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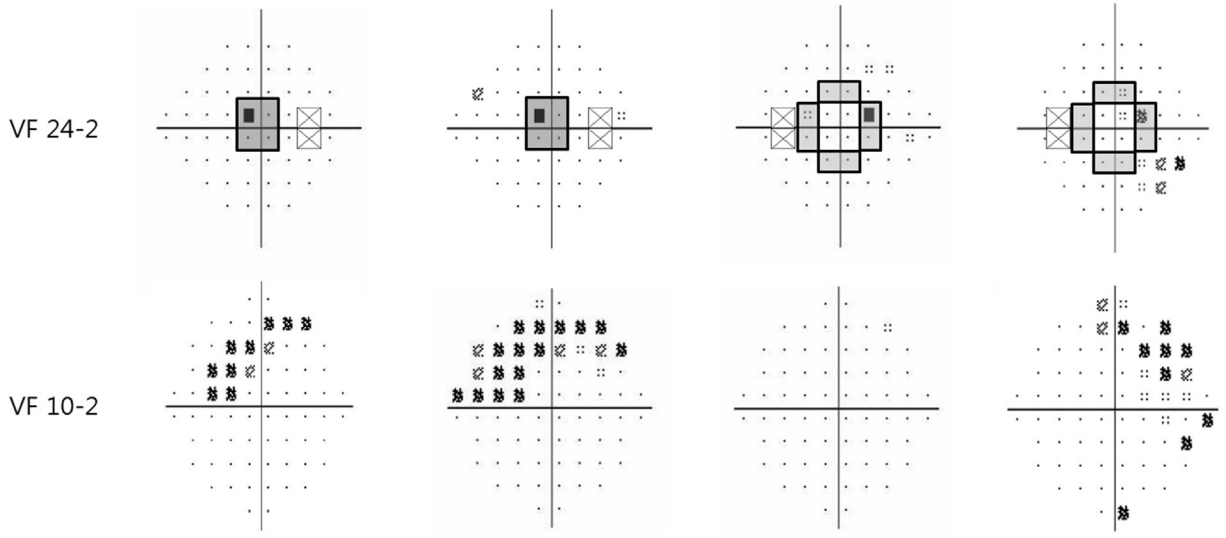

FIGURE 1. Representative cases with abnormal visual field (VF) points within the central 12 points on the Humphrey 24-2 VF test. The central 12 points are composed of the innermost central 4 points (first 2 cases, gray box) and paracentral 8 points (2 points adjacent to innermost central 4 points in each quadrant, latter 2 cases, light gray box). Any abnormal points depressed < 5% (:), < 2% (▨), < 1% (▩), or < 0.5% (■) from the normative database on the 24-2 VF test were analyzed. In the 10-2 VF test, an abnormal pattern deviation probability plot with the presence of parafoveal scotoma was defined as containing 3 or more contiguous points (5%, 5%, and 1% or 5%, 2%, and 2% depressed). Some abnormal points on the 24-2 VF test represent parafoveal scotomas on the 10-2 VF test. However, they are not always associated with parafoveal scotomas on the 10-2 VF test.

Glaucoma patients with MD better than −6 dB were prospectively tested with a 10-2 VF test. This study was conducted in accordance with the ethical standards stated in the Declaration of Helsinki and with the approval of the Institutional Review Board of Seoul St Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea. Informed consent was obtained from each patient.

For the initial evaluation, each patient received a complete ophthalmic examination, including a review of the medical history, measurement of best-corrected visual acuity, refraction, slit-lamp biomicroscopy, gonioscopy, Goldmann applanation tonometry, central corneal thickness using ultrasound pachymetry (Tomey Corporation, Nagoya, Japan), axial length using ocular biometry (IOL Master; Carl Zeiss Meditec), dilated stereoscopic examination of the optic disc, disc and red-free fundus photography (Kowa VX-10; Kowa Medicals, Torrance, California, USA), Cirrus optical coherence tomography (OCT; Carl Zeiss Meditec), and a Humphrey VF examination (Carl Zeiss Meditec). All examinations were performed within 1 month.

For a glaucoma diagnosis, patients had to have a glaucomatous optic disc appearance (such as diffuse or localized rim thinning, a notch in the rim, or a vertical cup-to-disc ratio higher than that of the other eye by more than 0.2 not explained by differences in the optic disc size) or a localized RNFL defect on disc and red-free photography confirmed by 2 glaucoma specialists (H.Y.P., C.K.P.), as well as an open angle on gonioscopic examination. All patients had to meet the following additional inclusion criteria to be entered into the study: a best-corrected visual acuity ≥20/40, a spherical refraction within ±6.0 diopters, a cylinder correction within ±3.0 diopters, and an MD better than −6 dB on the 24-2 VF test. Patients were excluded on the basis of any of the following criteria: a history of any retinal disease, including diabetic or hypertensive retinopathy; a history of eye trauma or surgery with the exception of uncomplicated cataract surgery; other optic nerve disease besides glaucoma; and a history of systemic or neurologic diseases that might affect the VF. If both eyes were eligible for the study, 1 eye was randomly chosen for the study.

• **VISUAL FIELD TEST AND CRITERIA FOR THE PRESENCE OF A PARAFOVEAL SCOTOMA ON A 10-2 TEST:** As shown in Figure 1, abnormal VF points in the central 12 points (depressed either <5%, <2%, <1%, or <0.5% from the normal database on pattern deviation plot) on a 24-2 VF test were analyzed. Any points involved in the central 4 points (innermost central 4 points) and the paracentral 8 points (2 points adjacent to innermost central 4 points in each quadrant) were considered. Enrolled patients underwent 10-2 VF tests within 1 month. Both 10-2 and 24-2 tests used the SITA [Swedish Interactive Threshold Algorithm] Standard strategy after refractive correction with a Goldmann size III target and background luminance (31.5 asb). All 10-2 and 24-2 VF tests analyzed were