Mobility Performance in Glaucoma

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Purpose. To determine whether glaucoma affects mobility performance and whether there is a relationship between mobility performance and stage of disease as estimated from vision–function measures.

Methods. The mobility performance of 47 glaucoma subjects was compared with that of 47 normal–vision subjects who were of similar age. Mobility performance was assessed by the time required to complete an established travel path and the number of mobility incidents. The subjective assessment of falling and fear of falling were also compared. Vision function was assessed by measures of visual acuity, contrast sensitivity, monocular automated threshold perimetry, and suprathreshold; binocular visual fields were assessed with the Esterman test.

Results. The glaucoma subjects walked on average 10% more slowly than did the normal–vision subjects. The number of people who experienced bumps, stumbles, or orientation problems was almost twice as high in the glaucoma group than the normal–vision group, but the difference did not reach statistical significance. The difference between groups also was not significant with respect to the number of people who reported falling in the past year (38% for the glaucoma group and 30% for the normal–vision group) or a fear of falling (28% for the glaucoma group and 23% for the normal–vision group). The visual fields assessed with a Humphrey 24-2 test were more highly correlated with walking speed in glaucoma than the visual fields scored by the Esterman scale or than visual acuity or contrast sensitivity.

Conclusions. Glaucoma is associated with a modest decrease in mobility performance. Walking speed decreases with severity of the disease as estimated by threshold perimetry. (*Invest Ophthalmol Vis Sci.* 1999;40:2803–2809)

Persons with advanced glaucoma have significantly reduced peripheral vision as measured by visual field tests. Because residual visual field is a significant predictor of mobility performance,[1–6] we expected that mobility performance would be affected in advanced glaucoma. However, no systematic study has addressed this issue. Nor is it known whether mild glaucoma damage might decrease mobility performance. In a recent study, we found that some persons with moderate glaucoma reported mobility difficulty when walking in unfamiliar areas, at night, and in crowded situations (authors' manuscript submitted, 1999). Past studies have investigated mobility performance in heterogeneous groups of visually impaired persons, only a small portion of whom had glaucoma.[1,6]

A variety of methods have been used to measure and score visual fields in mobility studies. Some studies have used diagnostic, threshold automated perimetry performed monocularly.[2,4] Other investigators used binocular field tests that were scored using various customized methods.[1,3,5,6] The American Medical Association has adopted one customized scoring method, the Esterman scale,[7–9] as a standard for rating visual field disability.[10] The Esterman scale evaluates the binocular visual field on the basis of the presumed usefulness of various parts of the visual field to the patient. Visual field areas thought to have the greatest functional importance, such as the lower visual field and the horizontal meridian, are sampled more finely than the other areas. The 120-unit grid covers 120° of the visual field and is tested binocularly with a single bright intensity.

Two studies have evaluated the relationship between Esterman scores and mobility function. Mills and Drance[11] compared subjective responses to questions about perceived visual disability with Esterman scores in 42 glaucoma subjects. Answers to the two mobility-related questions "Do you bump into things?" and "Do you trip on things?" were moderately correlated with the Esterman scores ($r = 0.52$ and 0.43, respectively). However, Haymes et al.[5] found no significant correlation between the Esterman scores and walking speed in 18 subjects with retinitis pigmentosa.

In this study, we compared the mobility performance of glaucoma subjects to normal–vision subjects who were of similar age. We wished to determine whether glaucoma affected mobility performance and whether there was a relationship between stage of glaucoma and mobility. We compared the subjective assessment of falling and fear of falling, walking speed, and several measures of vision function. The latter included visual acuity, contrast sensitivity, monocular automated threshold perimetry, and suprathreshold; binocular visual fields were assessed with the Esterman test.

Methods

Subjects

A total of 94 subjects participated in this experiment, 47 subjects had open-angle glaucoma and 47 subjects were per-

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sons with normal vision. The mean ages of the two groups were 65.1 and 60.2 years, respectively, not a statistically significant difference [t (92) = −1.98, NS]. Subjects with glaucoma were recruited from the Glaucoma Service at the Wilmer Eye Institute. The glaucoma subjects had a complete ophthalmological examination by a glaucoma specialist (HAQ) on the day of testing. Open-angle glaucoma was defined as present when a subject had gonioscopically open angles in both eyes and a reproducible visual-field abnormality in at least one eye. Field abnormality consisted of a Glaucoma Hemifield Test result of "outside normal limits" or a corrected pattern standard deviation (CPSD) result with <5% chance of being within normal limits on Humphrey 24-2 testing. In addition, the optic disc of an eye with field defect had to have a finding compatible with glaucoma damage, including progressive enlargement of cup/disc ratio, notch defect of the neuroretinal rim, cup/disc ratio >0.7, or excavation of disc rim.

The normal–vision subjects were spouses or friends of the patients, employees, or recruits from the Lions Vision Center database of normal–vision subjects. The normal–vision controls had no family history of genetic eye diseases or glaucoma, no retinal pathology or past retinal surgery, best-corrected visual acuity better than or equal to 20/30, and log contrast sensitivity better than or equal to 1.5.

Any subject with self-reported physical limitations (e.g., orthopedic), cognitive limitations (e.g., Alzheimer's Disease), or health limitations (e.g., heart condition) was excluded from participation. Informed consent was obtained from each subject after the nature and possible consequences of the study were described. The research followed the tenets of the Declaration of Helsinki and was approved by the institutional human experimentation committee.

Procedure

Two courses were selected to measure mobility performance. On each course, the subject was instructed to walk the established path as quickly and safely as possible, while avoiding all obstacles. Path 1 was a hallway 29-m long, without obstacles or turns and with minimal pedestrian traffic. The median number of people present was 1 during testing of the normal–vision group (lower quartile: 0; upper quartile: 1) and 1 during the testing of the glaucoma group (lower quartile: 0; upper quartile: 2). The median number of people within 2 feet of subjects was 0 for the normal–vision group (lower quartile: 0; upper quartile: 1) and 1 for the glaucoma group (lower quartile: 0; upper quartile: 1). Illumination along path 1 ranged from 74.3 to 245.4 lux. The subject was instructed to walk down the hallway, avoiding any obstacles, and to walk until asked to stop. Path 2 was also 29 m in length and consisted of a course through a clinic waiting room with chairs and tables. It included four right-angle turns and moderate pedestrian traffic. The median number of people present was 4 during testing of the normal–vision group (lower quartile: 1; upper quartile: 6) and 5 during testing of the glaucoma group (lower quartile: 1; upper quartile: 9). The median number of people within 2 feet of subjects was 2 for the normal–vision group (lower quartile: 1; upper quartile: 4) and 2 for the glaucoma group (lower quartile: 1; upper quartile: 5). Illumination along path 2 ranged from 88.3 to 199.1 lux. The subject was instructed to walk through the waiting room, making the appropriate turns. Before beginning each path, the subject repeated the directions to assure that they were understood. A trained observer always followed closely behind. The subject walked the course with his or her normal refractive correction. To estimate the effect of practice, subjects traveled each path twice. The second time through on each path, the direction of the course was reversed.

Mobility performance was assessed by the time required to complete an established travel path and the number of mobility incidents, which included bumps, stumbles, and orientation problems. A bump was defined as a body contact above the knee, excluding the hands, with any object or person. A stumble was defined as a change in posture or gait as a result of contact with an object below the knee. An orientation problem was defined as a change in direction that was not consistent with the instructions. Travel time was converted into walking speed (meters per second) by dividing the distance of the established travel path by the time to complete the course. The converted measure permits a direct comparison of mobility performance across other routes and studies.

Measures of vision function included visual acuity, contrast sensitivity, and visual fields. Visual acuity was measured binocularly using a Lighthouse ETDRS acuity chart[12] transilluminated at approximately 100 cd/m^2. The viewing distance was 3 m. Visual acuity was reported as the logarithm of the minimum angle of resolution (log MAR), computed by multiplying the number of letters correctly read by 0.02 and subtracting from 1.22. Contrast sensitivity was measured binocularly using the Pelli-Robson chart[13] with overhead illumination of 85 cd/m^2 at a viewing distance of 1 m. Log contrast sensitivity (log CS) was scored as the product of 0.05 and the number of letters correctly read minus 3. Visual fields were measured binocularly in both the normal–vision and glaucoma subjects using the Esterman test[9] on the Humphrey Visual Field Analyzer. The Esterman test evaluates the ability of the observer to detect a stimulus equivalent to the Goldmann III/4e (0.43° stimulus at 320 cd/m^2 on a 10 cd/m^2 background) at each of 120 locations in the visual field. The locations extend to ±60° along the vertical meridian and to ±75° along the horizontal meridian. The stimulus is presented for 400 msec. Subjects wear their spectacles or contact lenses during the test. For the glaucoma subjects only, the visual field of each eye was also tested monocularly with the 24-2 threshold program of the Humphrey Visual Field Analyzer.[14] The 24-2 threshold program tests each of 54 locations within the central ±24°. At each location, the minimum luminance required to detect a 0.43° stimulus on a background of 10 cd/m^2 is determined. The stimulus is presented for 200 msec. Threshold is reported in terms of the maximum amount of brightness attenuation (in decibels, which is equivalent to 0.1 log unit). Global indices, such as the mean deviation (MD) and CPSD, are determined from the local threshold values. Mean deviation is the average of the differences in decibels between the age-corrected normal threshold and the threshold of the subject over all tested points in the visual field. This measure is an estimate of the general loss of sensitivity across the visual field. The CPSD is an estimate of localized loss and is determined by adjusting the differences in decibels between the age-corrected normal threshold and the subject's threshold for shifts in overall sensitivity and intratest variability. Both global indices are used as indicators of the stage of disease.

All subjects were asked to answer yes or no to two questions on mobility-related behaviors, "Have you fallen in the last year?" and "Have you had a fear of falling in the last year?

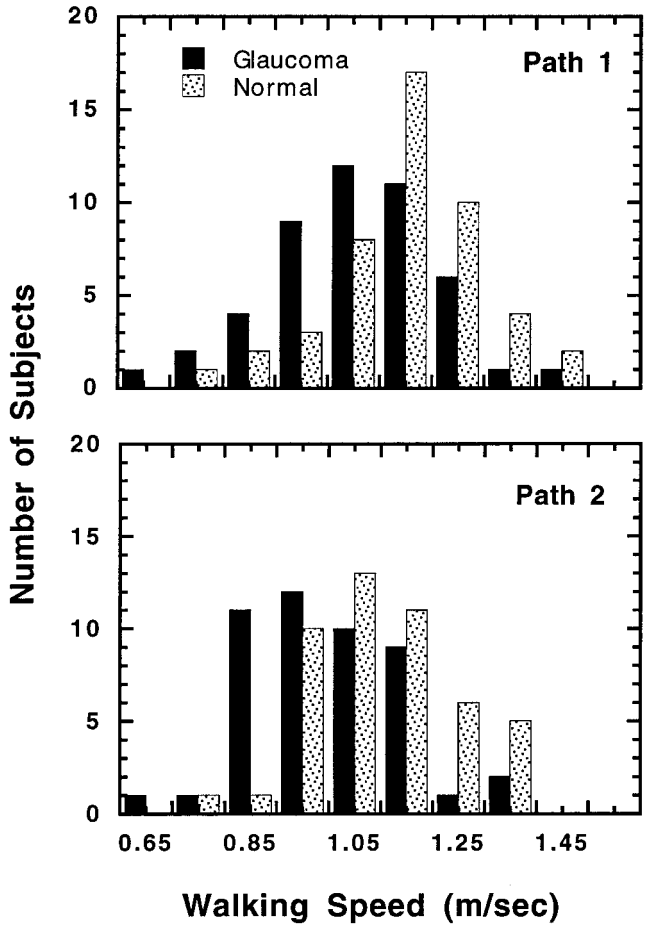

FIGURE 1. Walking-speed distributions for the glaucoma (*shaded*) and normal-vision (*dotted*) subjects for paths 1 (*top*) and 2 (*bottom*).

"Fallen" was defined as unintentionally coming to rest on the ground or at some lower level. "Fear of falling" was defined as being anxious or worried about falling or being frightened of falling. These may or may not have been associated with a feeling of unsteadiness.

RESULTS

Mobility Performance

The mean walking speed of the glaucoma subjects for path 1 was 1.06 m/sec (SD = 0.15) and 0.99 m/sec (SD = 0.15) for path 2. These speeds were slower than the average speeds of the normal-vision subjects, which were 1.15 m/sec (SD = 0.14) and 1.10 m/sec (SD = 0.15) for paths 1 and 2, respectively. The walking-speed distributions for the glaucoma and normal-vision subjects overlapped considerably (Fig. 1). A repeated-measure ANCOVA was performed on the walking speeds of the subjects with age as the covariate, using the multivariate model of the statistical package JMP (SAS, Cary, NC). Subject group (glaucoma, normal vision) served as the between-subject factor, and complexity of path (Paths 1, 2) and trial served as the within-subject factors. There were significant main effects of subject group [$F(1,91) = 8.43$, $P < 0.01$] and path complexity [$F(1,91) = 21.04$, $P < 0.01$], indicating that glaucoma subjects walked more slowly than normal-vision subjects and that greater path complexity slowed both groups. Because there was no difference between initial and secondary trials, we analyzed walking speed as the mean walking speed of the two trials for each subject and path.

Four normal-vision subjects and 7 glaucoma subjects had at least 1 mobility incident. Three subjects had more than 1 incident; one normal-vision subject and one glaucoma subject had 2 incidents, and another glaucoma subject had 3 incidents. All mobility incidents were orientation problems, except one stumble by a glaucoma subject. Although the number of subjects who had a mobility incident was almost twice as high in the glaucoma group than in the normal-vision group, the difference was not statistically significant ($\chi^2 = 0.93$, NS).

The glaucoma and normal-vision subjects did not differ in their responses to the mobility-related questions. Eighteen (38%) glaucoma subjects reported falling in the last year, not significantly different from the normal-vision subjects (14; 30%; $\chi^2 = 0.77$, NS). The number of glaucoma subjects who reported a fear of falling (13; 28%) was similar to the number in the normal-vision group (11; 23%; $\chi^2 = 0.23$, NS).

Vision–Function Measures

By study design, because of exclusion criteria for the normal-vision subjects, the two subject groups differed significantly on the vision-function measures (Table 1). LogMAR was significantly higher in the glaucoma group (indicating that visual acuity was worse) compared with the normal-vision group (Wilcoxon test, $Z = 5.35$, $P < 0.001$), and logCS was significantly lower in the glaucoma group (Wilcoxon test, $Z = -6.64$, $P < 0.001$). The Esterman scores were significantly lower in the glaucoma group compared with the normal-vision group (Wilcoxon test, $Z = -3.94$, $P < 0.01$). Stage of disease was broadly distributed in our sample of glaucoma subjects, indicated by the wide range of MD and CPSD scores. The CPSD scores for the better eye ($CPSD_{better}$) ranged from 13.21 to 0 (median, 4.6) and for the worse eye ($CPSD_{worse}$) the scores ranged from 15.53 to 0.57 (median, 9.43). The MD scores for the better eye (Md_{better}) ranged from −25.52 to 1.07 (median, −8.34) and for the worse eye (MD_{worse}) the scores ranged from −30.92 to 1.06 (median −14.93).

To determine the significance of association between the vision-function measures of the glaucoma subjects, correlation coefficients were computed. (Coefficients of rank correlations were used throughout this article because many of the measures were not normally distributed.) Several of the vision-function measures were significantly correlated with each other (Table 2). For example, the visual-field measures MD and Esterman score were correlated with each other, as were MD and CPSD. LogCS was correlated with MD, Esterman, and logMAR. Also correlated, but not reported in Table 2, were the CPSD scores of the right and left eyes ($\rho = 0.51$) and the MD scores of the right and left eyes ($\rho = 0.58$).

Vision–Function Predictors of Walking Speed in Glaucoma

The distribution of Esterman scores was skewed toward the higher values, with 50% of the scores ≥87 (Fig. 2). The superposition of the symbols for the normal-vision subjects and the glaucoma subjects indicates that some glaucoma subjects fell within the normal ranges for walking speed and Esterman scores. There was only a modest correlation between walking

TABLE 1. Subject Characteristics

	Normal (n = 47)				Glaucoma (n = 47)			
	Min	**Max**	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**
Age	32.8	82.8	60.2	12.7	29.7	79.6	65.1	11.40
LogMAR	−0.18	0.18	−0.08	0.10	−0.18	1.16	0.15	0.26
LogCS	1.50	1.95	1.80	0.11	0.75	1.85	1.49	0.25
MD (better eye)					−25.5	1.1	−10.1	8.41
MD (worse eye)					−30.9	1.1	−16.5	10.00
CPSD (better eye)					0.00	13.20	4.90	3.72
CPSD (worse eye)					0.60	15.50	8.10	3.88

	Min	**Max**	**Median**	**Upper 25%**	**Lower 25%**	**Min**	**Max**	**Median**	**Upper 25%**	**Lower 25%**
Esterman	80	100	94	97	89	28	100	87	94	70

LogMAR, the logarithm of the minimum angle of resolution; LogCS, the logarithm of the peak contrast sensitivity measured with the Pelli-Robson chart; MD, the mean deviation of the Humphrey 24-2 test; and CPSD, the corrected pattern standard deviation of the Humphrey 24-2 test.

speed and the Esterman scores for the glaucoma subjects (Spearman's $\rho = 0.43$ and 0.39 for paths 1 and 2, respectively). Table 3 lists the correlation coefficients for the vision factors and walking speed of the glaucoma subjects. Among the visual field measures, MD_{worse} correlated most highly with walking speed ($\rho = 0.57$ and 0.49 for paths 1 and 2, respectively). Figure 3 shows the relationship between walking speed and MD_{worse} for the glaucoma subjects. Also statistically significant were the correlations between walking speed and the average of the two eyes' MD scores, MD_{better}, and Esterman score. Walking speed was also moderately correlated with logMAR and logCS. The CPSD scores and the difference in MD scores between the two eyes were not significantly correlated with walking speed.

β-Blockers and Mobility Performance in Glaucoma

To determine whether β-blockers affected mobility performance of the glaucoma subjects in this study, we examined the relation between the use of β-blockers and walking speed. Approximately half of the glaucoma subjects (23/47) used β-blockers. Their mean walking speed was 1.07 m/sec for path 1 and 1.01 m/sec for path 2. The mean walking speeds of the glaucoma subjects who did not use β-blockers were 1.04 and 0.98 m/sec for paths 1 and 2, respectively. Walking speeds were not significantly different for the two groups of glaucoma subjects on either path, $t(45) = -0.56$, NS, for path 1 and $t(45) = -0.70$, NS, for path 2.

We examined the relation between falling and the use of β-blockers. In our study, of the 18 glaucoma subjects who reported falling in the last year, only 7 used topical β-blockers. The results of a Pearson chi-square analysis showed no statistical dependence between the use of topical β-blockers and falling ($\chi^2 = 1.5$, NS). Seven glaucoma subjects reported two or more falls in the past year. Out of this group, only 2 used β-blockers. The results of a Pearson χ^2 analysis showed no statistical dependence between use of β-blockers and two or more falls in the past year ($\chi^2 = 1.4$, NS). The glaucoma subjects who used β-blockers did not differ from those who did not use β-blockers with respect to age, logMAR, logCS, MD, or CPSD.

DISCUSSION

Our data support the conclusion that glaucoma is associated with decreased mobility performance. Although there was substantial overlap between the distributions of the two groups in walking speeds, the mean walking speed of the glaucoma subjects was 10% slower than the mean walking speed of the normal–vision subjects. Some glaucoma subjects walked significantly slower (40%) than the mean walking speed of the

TABLE 2. Correlation Coefficients (Spearman's ρ) of Vision Factors for the Glaucoma Subjects

	LogMAR	**LogCS**	**MD better eye**	**MD worse eye**	**CPSD better eye**	**CPSD worse eye**	**Esterman**
LogMAR	1						
LogCS	−0.72*	1					
MD (better eye)	−0.52*	0.69*	1				
MD (worse eye)	−0.52*	0.65*	0.78*	1			
CPSD (better eye)	0.23	−0.32	−0.65*	−0.39*	1		
CPSD (worse eye)	0.16	−0.17	−0.47*	−0.37*	0.76*	1	
Esterman	−0.43*	0.57*	0.74*	0.63*	−0.35	−0.12	1

* $P < .01$.

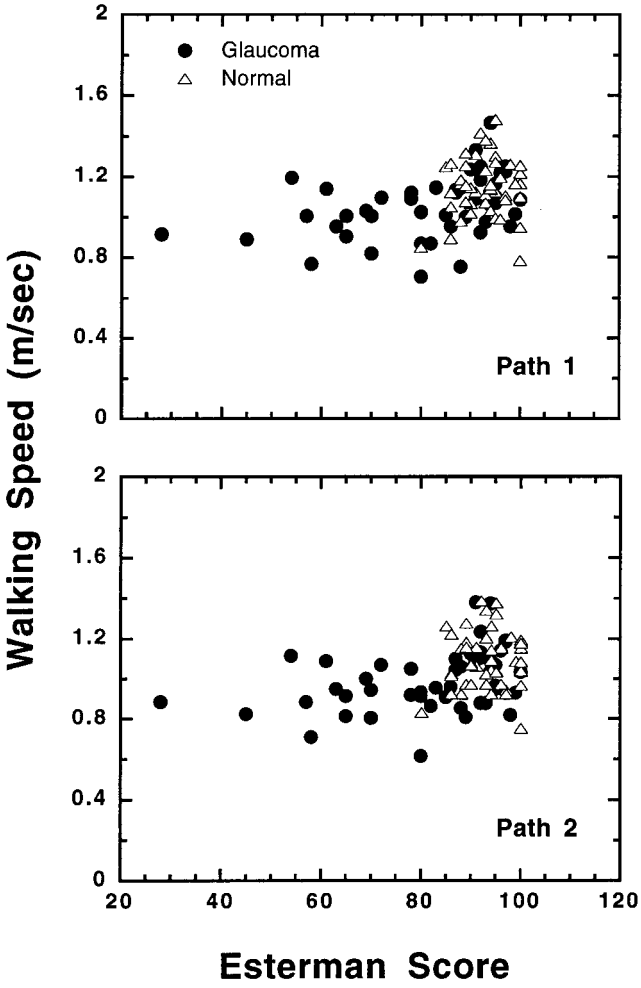

FIGURE 2. Walking speed (m/sec) plotted as a function of Esterman scores. Data of the glaucoma subjects are shown as *circles* and the data of the normal-vision subjects are shown as *triangles*. Walking speed for path 1 (*top*) and path 2 (*bottom*).

normal-vision subjects, whereas other glaucoma subjects walked faster (30%) or at the same speed.

Surprisingly, MD_{worse} from the Humphrey threshold test had the highest correlation with walking speed among the visual field variables for the glaucoma subjects. The Humphrey 24-2 test is performed monocularly and extends only ±24° along the horizontal meridian, whereas the Esterman test is performed binocularly and its test locations extend to an eccentricity of 75°. In past studies,[1–6] extent of remaining visual field has been shown to be a significant predictor of mobility performance. Therefore, we expected that a test that assessed a larger portion of the visual field would be more strongly related to walking speed. It is likely that the narrow range of Esterman scores is due to the high light level of the Esterman stimulus, producing scores that are strongly skewed toward the high end of the scale. The Humphrey 24-2 test estimates threshold at 54 locations, whereas the Esterman test measures whether or not the subject can detect a single intensity (10 dB) at 120 locations with either eye (46 locations within ±24°). We speculate that improved correlation of mobility with functional testing might be obtained by combining the wide binocular approach with a threshold-related strategy.

It is interesting that MD in the "worse" eye was more highly correlated with walking speed than MD in the better eye. MD is a measure of the general loss in sensitivity. A loss of sensitivity results in a reduced effective contrast for stimuli viewed with that eye. Mansfield and Legge[15] demonstrated that the calculation of visual direction is affected by unequal contrast in the two eyes. They showed that the accuracy for binocular visual direction is limited by the noise in the "most sensitive" monocular channel. If the slow walking speed of the glaucoma subjects in our study was simply a matter of a miscalculation of visual direction we would expect walking speed to be more highly correlated with the MD score in the better eye than in the worse eye, but it was not.

Stereopsis, the ability to judge relative depth binocularly, has been shown to be limited by the noise in the "least sensitive" monocular channel.[16] To successfully navigate, one has to determine the spatial layout of objects within the environment. It is possible that accurate judgments of stereoscopic depth play a role in determining the spatial layout of objects and, ultimately, may affect walking speed. Support for this alternative comes from studies that have shown that persons with poor stereoacuity have an increased risk of two or more falls[17] and also hip fracture.[18]

Finally, monocular vision has been shown to provide unreliable estimates of time to collision (TTC) with an approaching small object.[19] Monocular vision has been compared with binocular vision with respect to judgments of TTC,[19] but to our knowledge, the effects of interocular sensitivity differences on TTC judgments have not been explored. Obviously, in the limit, a person with significantly reduced MD_{worse} would behave as a person with monocular vision and would fail to reliably estimate TTC. The inability to estimate TTC within the time necessary to make an appropriate motor response can increase the chance of collision. Therefore, persons who are unable to reliably estimate TTC might compensate by slowing their walking pace.

On the whole, the vision-function measures were more highly correlated with walking speed for the simple path than for the complex one. It is possible that factors other than vision may have limited walking speed on the complex path. For example, even though the subjects were required to repeat the directions before walking, they may have forgotten or mixed

TABLE 3. Correlation Coefficients (Spearman's ρ) of Vision Factors and Walking Speed for Glaucoma Subjects

	Walking Speed Path1	Walking Speed Path2
LogMAR	−0.45*	−0.34†
LogCS	0.50*	0.41*
MD (better eye)	0.49*	0.38*
MD (worse eye)	0.57*	0.49*
CPSD (better eye)	−0.29	−0.21
CPSD (worse eye)	−0.23	−0.19
Esterman	0.43*	0.39*
MD (difference between eyes)	−0.29	−0.32†
MD (average of the eyes)	0.53*	0.44*

* $P < .01$.
† $P < .05$.

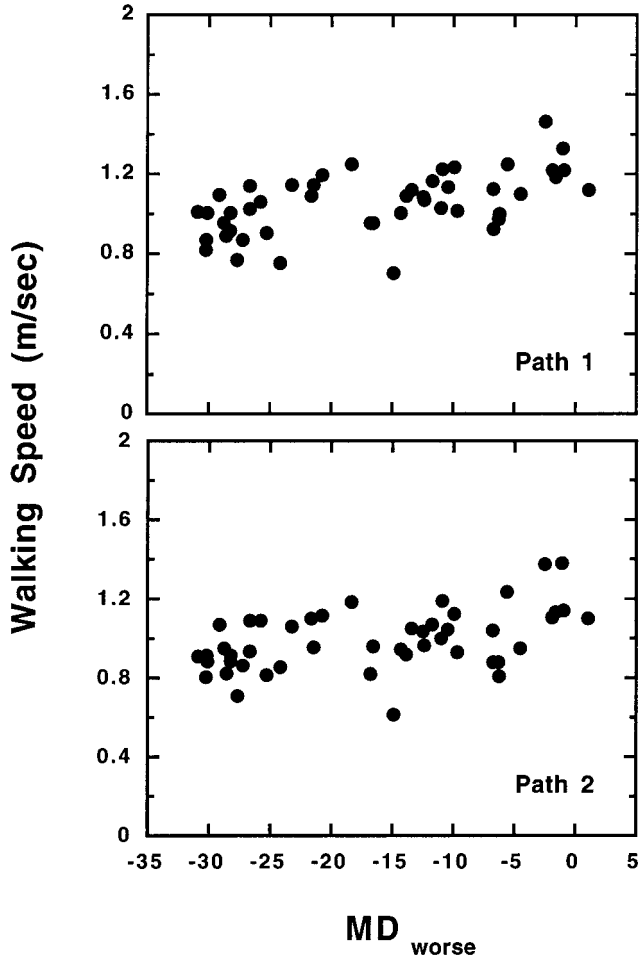

FIGURE 3. Walking speed (m/sec) plotted as a function of mean deviation for the worse eye (MD_{worse}). Walking speed for path 1 (*top*) and path 2 (*bottom*). Data are for the glaucoma subjects.

up the directions after starting. Because glaucoma and normal-vision subjects had some orientation problems, memory may play an increased role in walking speed on path 2.

The number of glaucoma subjects who had an orientation problem or a stumble was almost twice as high as the number of normal-vision subjects, although the difference did not reach statistical significance. The probability of detecting a statistically significant result at the 0.05 level (i.e., the power of the test), given our parameter values and sample size, was less than 20%. Based on the current results, a sample size of 397 subjects would be required to demonstrate whether or not the difference we observed was statistically significant.

There was no significant difference between the two groups with respect to reported falling (38% for the glaucoma group and 30% for the normal-vision group) or fear of falling (28% for the glaucoma group and 23% for the normal-vision group). The prevalence of falling (30%) in this age group of normal-vision subjects is similar to that reported in previous epidemiologic studies.[20–24] Moreover, the prevalence of falling was similar in glaucoma and normal-vision groups in a large-scale population-based study of persons 65 years and older that was conducted by the second author.[25] In that study, 27% (214/794) of the normal subjects with visual acuity of 20/20 or better reported falling in the last year. Among the subjects who were classified as having glaucoma, 33% (4/12) reported falling in the past year, (χ^2 = 0.24, NS; authors' unpublished data, 1997). (Only subjects whose visual acuity was worse than 20/40 had a recorded diagnosis.) We conclude that the presence of glaucoma or the visual impairment associated with it plays only a partial role in falls. Perhaps glaucoma subjects have adopted precautions (such as slowing their walking pace, altering their environment, or restricting their travel) to minimize the chance of a fall.

A commonly prescribed glaucoma treatment used to lower intraocular pressure is the application of topical β-blockers. A recent study reported that the β-blocker timolol reduced exercise tolerance in a group of patients over 60 years of age.[26] The study showed that those who changed from timolol to betaxolol or dipivefrine walked significantly farther in a 2-minute period than those who remained on timolol. The shorter walking distance of those who remained on timolol was attributed to impaired respiratory function, a side effect of the medication.

One study showed that persons who used nonmiotic glaucoma medications (90% of which were topical β-blockers) had five times the odds of a fall (OR = 5.4, 95% CI = 1.8–16.4) compared with those not using these medications.[27] Another study reported that those who used nonmiotic medications had a prevalence ratio of 2.0 for two or more falls in the past year (95% CI = 1.1–3.6) compared with those who did not use nonmiotic medications.[28] A third study showed no significant relation between systemic β-blockers and falling.[29] We found no relationship between the use of β-blocker eye drops and either walking speed, reported falls, or patient characteristics among glaucoma subjects. Hence, it is likely that the decreased walking speed of those with glaucoma is due to factors other than their prescribed medications.

In summary, persons with glaucoma walked, on average, more slowly than did the normal-vision persons. The number of people who experienced bumps, stumbles, or orientation problems was almost twice as high in the glaucoma group than the normal-vision group, but the difference did not reach statistical significance. Finally, walking speed in glaucoma subjects was more highly correlated with visual fields assessed with a Humphrey 24-2 test than with the Esterman test, visual acuity, or contrast sensitivity.

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