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Commentary Open Access

Reading Performance in Glaucoma

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Commentary

In clinical setting, visual field is the most important functional measure for staging and monitoring progression of disease. However, visual field poorly reflects the impact of glaucoma on daily activities. Weak associations have been reported between various visual field measures and visual disability using different questionnaires [1,2]. Self-perceived visual disability is a subjective measure and is influenced by other factors such as co-morbidities, personality type, gender, social and educational level, and use of topical medication [3-5]. Therefore, measuring task performance may represent a more objective measure to understand how glaucoma affects daily activities.

In the population aged 55 years and more, glaucoma was the main cause of visual field loss, and was associated with diminished enjoyment of reading and watching television even after adjusting for visual acuity [6]. Patients with glaucoma self-report more difficulties for different reading tasks and spend less time in reading activities, especially those requiring sustained reading [7]. The study evaluating quality of life and priorities in patients with glaucoma showed that the severity of glaucoma influenced relative importance of priorities. Patients with significant peripheral visual field loss assigned greater value to their central vision and activities such as reading and seeing details than did patients with less advanced disease [8].

Recently, more papers have addressed reading ability in patients with glaucoma. Slower reading speed compared to age-matched visually healthy subjects was found already in patients with mild to moderate glaucoma and good visual acuity [9]. The Japanese version of Minnesota Reading Acuity Chart (MNRead) was used and subjects read aloud at the distance of 30 cm in a vertical direction from the right to the left row.

In a population-based study including 1154 elderly subjects, of those 137 patients with glaucoma, only patients with advanced bilateral visual field loss had decreased reading speed [10]. Subjects read aloud short passages of text on the computer screen straight ahead, unlike physiological reading looking down towards a page, which may have reduced the impact of inferior visual field loss. Reading speed decreased with better-eye MD (β =- 2.9 words/min/ dB of visual field loss; P=0.004) without visual acuity in the model. This effect was absent when visual acuity was included in the model, indicating that the effect of visual field loss on reading speed was mediated through decrease of visual acuity. Visual acuity was the most significant predictor of reading speed with a decrease of 15 words/min for each line loss of Snellen visual acuity. Multivariable regression analysis demonstrated, that for the most severely affected quartile of subjects with bilateral glaucoma (average better-eye MD of -22.5 dB) reading speed was 32 words/min slower than for subjects without glaucoma but with wide confidence interval (95% CI, −56 to −7 words/min; P=0.01).

In a recent study we investigated the association between self-reported visual difficulties using Glaucoma Quality of Life (GQL)-15 Questionnaire, visual function and reading performance in 63 patients with different severity of glaucoma with good visual acuity (better-eye Snellen visual acuity of 0.6 or better) compared to visually healthy people [11]. The standardized International Reading Speed Texts (IReST) was used to assess reading performance. Patients with glaucoma were slower readers than healthy controls (127 words/min, and 156 words/min; P=0.001), but did not report more difficulties with central vision of the GQL-15. This is not unexpected, as the central vision subfactor represents only 2 out of 15 items of the GQL-15 questionnaire. Better-eye MD, used as a summary measure of visual function loss in patients with glaucoma, correlated significantly with reading speed (r=- 0.41; P=0.001), GQL-15 summary score (r=0.29; P=0.02), peripheral vision score (r=0.34; P=0.006), age (r=0.27; P=0.03), and better-eye visual acuity (r=- 0.25; P=0.046). Reading speed decreased with better-eye MD (β=- 1.5words/min/ dB of visual field loss; P=0.003), better-eye visual acuity (β=8.2 words/min/line of Snellen visual acuity loss; P=0.007), and age (β=- 6.6 words/min/ decade older age; P=0.009). In multiple regression analysis s better-eye MD was an independent predictor of reading speed and contributed together with age and better eye visual acuity to 37% of variation in reading speed, suggesting that approximately 60% variation in reading speed is due to other factors [11]. Similarly, Legge et al., found that clinical predictors such as visual acuity, age, central visual field and diagnosis of age-related macular degeneration accounted for only 30% variation in low-vision reading speed [12]. Additional variables affecting reading speed are the level of education, cognitive ability, race (African American) even after adjusting for education, skill and reading habits [10,13].

When reading aloud patients with more severe glaucoma make more lexical errors, slower recite longer and less frequently used words, and need more time to change reading lines [14].

Reading performance in patients with bilateral glaucoma is even more reduced during sustained silent reading than reading aloud short passage of text [15]. After adjusting for age, race, sex, education, employment, and cognition, the IReST and MNRead reading speeds were 6%-7% (12 words/min) slower among glaucoma patients compared to controls (P<0.001), while sustained silent reading speed was 16% slower. A decline of reading speed of 0.5 words/min or more during sustained reading was more common in patients with glaucoma than controls. It seems that patients with glaucoma fatigue more during sustained silent reading, which is also a common complaint in clinical setting.

Patients with glaucoma are more sensitive to letter contrast than age-similar visually healthy people. A reduction of reading speed caused by a decrease in letter contrast from 100% to 20% was significantly greater in patients than controls [16]. The extent of

reading speed reduction due to contrast lowering of text was related to the severity of disease, with more significant reduction of reading speed in patients with worse better-eye MD, poorer visual acuity, and poorer contrast sensitivity.

Some studies found that poorer functional status and self-reported reading disability among patients with glaucoma were associated with the inferior visual field loss, in particular within 5 of the fixation and along the horizontal meridian [17,18].

Another study, investigating relationship between patient-reported outcome and location of the visual field defect found that superior hemifield of the binocular (integrated) visual field was strongly associated with near activities, whereas inferior hemifield of the integrated visual field had greater impact on vision-specific role difficulties and general and peripheral vision [19]. Recently, exploring association of different areas of binocular visual field with measured reading speeds in patients with glaucoma and preserved visual acuity has shown that the inferior left section of the integrated visual field was most likely associated with reading speed and may be important for changing lines during reading [20].

Different eye movement behaviour may partly account for the variability in reading speed among patients with advanced visual field loss in both eyes [21]. Significant association between saccadic frequency and reading speed was observed in the patient group and not in controls. This may indicate that patients make additional saccades that impair reading speed. Patients also needed to saturate each line of the text more than controls when reading short passages suggesting increased requirement to fixate on all the words in a line of text. Interestingly, despite advanced visual field loss some patients read as efficiently as controls possibly by adopting different fixation behavior as shown by eye tracking [21]. Monitoring eye movement to static targets demonstrated that patients with bilateral visual field loss had delayed and less accurate saccades compared to those of healthy subjects suggesting an impairment of saccade programming and execution [22].

In conclusion, glaucoma is a major cause of visual field loss in the older population and affects reading performance. Patients with bilateral visual field loss despite good visual acuity report more difficulties with reading and engage less in various reading activities [7]. Studies demonstrated on average decreased reading speed in patients with glaucoma, which was more pronounced during sustained silent reading, compared to visually healthy people. Reading speed varies among patients with similar extent of visual field loss also when adjusting for known confounders, such as age, general health, cognitive ability, reading habits, and education. Similarly, in visually healthy subjects using the IReST test, the between-individual differences were the main cause of variability in reading speed [23]. Currently, improving letter contrast, increasing luminance, possibly change of reading format (e.g. from portrait to landscape) to reduce transition of lines may decrease reading disability.

Further research exploring the mechanisms by which glaucoma affects reading ability and efficient, compensatory eye movement behaviour may help in clinical management and rehabilitation of patients with glaucoma.

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