Glaucoma patients showed an alteration of performance in simulated daily living activities, associated with a decreased QoL. There was no clear correlation between alterations in QoL and ability to perform activities of daily living. The QoL related to vision was mostly correlated to the visual function of the worse eye.

Key Words: Glaucoma, quality of life, visual field, activities of daily living, mobility, reaching and grasping

(J Glaucoma 2020;29:970–974)

Glaucoma is one of the leading causes of irreversible blindness; it may affect up to 111.8 million people worldwide in 2040.1 It is generally characterized by a progressive loss of retinal ganglion cell axons, associated with a reduction of visual field (VF).2,3 The progressive visual function loss, as well as the medical or surgical treatment, or even the diagnosis of glaucoma itself, can affect the daily life of glaucoma patients and, consequently, their quality of life (QoL).4 QoL is a complex and subjective concept that involves the individual perception of emotional, physical, material, and social factors. As the goal of glaucoma treatment is to preserve the patient’s QoL, direct or indirect evaluation of QoL is of central importance in the management of the glaucoma patient.

In contrast to visual impairment and stage of glaucoma, which can be measured precisely by objective tests such as visual acuity (VA) measurement, contrast sensitivity, and VF testing, evaluation of the impact of glaucoma on daily activities and QoL remains a challenge.5 The monocular VF is the gold standard used in clinical practice to evaluate glaucoma patients’ visual function and glaucoma progression, so as to adjust treatment accordingly.6 The better eye VF mean deviation (MD) has been directly correlated with visual function and is used in QoL studies in glaucoma.7–9 As glaucoma patients use one eye to compensate for the other, binocular VFs, or systems integrating both monocular VF tests to reproduce a binocular VF, are also used.10–12 However, using a concomitant evaluation of 4 different activities of daily living, our group showed, consistently with several other studies, that neither monocular nor bilateral VFs can thoroughly describe the effect of glaucoma on a patient’s everyday activities of daily living.9,13–16

Although visual impairment due to glaucoma has a significant negative impact on patients’ ability to perform activities of daily living, the exact correlation between objective visual changes and their consequences on QoL are not fully understood and remain difficult to evaluate. Simply stated, patients with similar visual function might experience...
different performance in activities of daily living and/or rate their QoL differently. Thus, the purpose of the present study was to evaluate correlations between subjective QoL evaluation and objective evaluation of visual function and performance in simulated activities of daily living, to better understand patients’ perception of their disease and disabilities.

METHODS

Participants
A total of 32 patients with glaucoma, aged 18 to 80 years, and 10 age-matched control subjects were included. All participants were informed of the purpose of the study, and their signed consent was obtained before inclusion. The study was approved by the Saint-Antoine Ethics Committee (CPP IDF VI P16-03) and the National Agency for the Safety of Medicines and Health Products (ANSM) (2016-A01371-50).

Glaucoma patients were followed-up regularly at the Quinze-Vingts National Ophthalmology Hospital, Paris, France. They were required to have stable glaucoma, confirmed with at least 3 VF tests over the past 3 years, and monocular VA in both eyes of at least 0.6 [best-corrected visual acuity (BCVA) < 0.2 logarithm of the minimum angle of resolution (LogMAR)]. They were required to be autonomous without motor or cognitive problems that could interfere with the patient’s full understanding of testing instructions. The noninclusion criteria were pregnancy or breastfeeding, inability to personally give informed consent, systemic disease, or medications that might cause visual or cognitive impairment.

Glaucoma patients were divided into 2 groups according to the Hodapp, Parish, and Anderson (HPA) classification. Sixteen patients were classified as stage 0, 10 as stage 1, and 6 as stage 2. Four patients had advanced glaucoma (EG group, stage 0 to 1), and 6 had advanced glaucoma (AG group, stage 2 to 4).

The control group (CO) had no systemic or ocular disease in terms of VF impairment or VA loss. Monocular VA in both eyes was at least 20/25 (BCVA < 0.1 LogMAR).

Procedure
All participants in the study underwent a self-administered QoL questionnaire, a complete visual function assessment, and an objective evaluation of simulated activities of daily living.

All patients underwent an evaluation of monocular and binocular BCVA, converted to the LogMAR, and a binocular contrast sensitivity test (LogCS). For all patients, monocular and binocular VFs were also recorded. For monocular tests, patients underwent a Humphrey perimeter 24-2 threshold test with the SITA-Standard program on the Humphrey Visual Field Analyzer (HFA) (Carl Zeiss Meditec, Dublin, CA). The MD index of the better (MD-BE) and worse (MD-WE) eyes was recorded. For the binocular VF, patients performed an Esternan binocular VF using the HFA. The Esternan score was reported as points out of the 120 points evaluated in a VF extending over 140 degrees horizontally and 110 degrees vertically.

The National Eye Institute Visual Function Questionnaire-25 (NEI VFQ-25) was used as a self-administered QoL questionnaire. The NEI VFQ-25 consists of 25 questions and 14 additional optional questions (total of 39 questions) that address 12 aspects of daily living: general health (GH), general vision (GV), ocular pain (OP), near activities (NA), distance activities (DA), social functioning (SF), mental health (MH), role difficulties (RD), dependency (Dp), color vision (CV), peripheral vision (PV), and driving (D). In this study, we evaluated the 39 questions except for the 2 questions about D, as most of the patients did not drive. We used a French translated version validated for glaucoma and ocular hypertension. Patients answered the questionnaires themselves or, when necessary, with the assistance of a family member. Each question has a score between 0 and 100, where “100” represents a better QoL. Results were distributed according to 12 subscores covering each of the 12 individual domains and a composite score (CS) representing the mean score of all subscores, except for GH, which is not directly related to the visual condition, and D, which was not analyzed in the present study.

Two different simulated activities of daily living were performed in the present study: a mobility task and a reaching and grasping task. Both tasks were performed on the StreetLab platforms of the Vision Institute (IHU FORESIGHT, Paris, France) according to previously validated protocols. These platforms provide a controlled environment with an adjustable light system and reproducible experimental conditions. Briefly, the mobility task consisted of a 15 m indoor course with controlled illumination intensity (250lux, 4350 K). Subjects were instructed to walk at their preferred walking speed, following an indoor route with various obstacles (chairs, desks, or tables). Four mobility courses with a similar level of complexity and number of obstacles were assessed in the same order for all subjects. The time to travel the path (TP) and the number of mobility incidents (MI), such as bumps, stumbling, or stops, were recorded during the trial. For the reaching and grasping tasks, the subject was seated in front of a counter with 3 small objects (S) and 3 large objects (L). They randomly performed 5 reach-and-grasp tasks for each target object, located on the right (near and far), on the left (near and far), or in the middle of the counter, in a randomized order. The movement onset (MO), representing visual search and movement initiation time, and the overall movement duration (OMD), corresponding to the reaching and grasping time, were recorded.

Statistical Analyses
R, v.3.4.2 Development Core Team (2008) was used for statistical analysis. Descriptive statistics were used to analyze demographic data. Qualitative variables, such as sex or errors in the various performance tasks, were compared between the CO group and the glaucoma groups with a χ² test. Quantitative variables were compared between groups using the nonparametric Kruskal-Wallis H test; multiple pairwise-comparisons between groups were calculated using the post hoc Dunn test (false discovery rate) with Benjamini-Hochberg adjustment for significant differences. Subsequently, in the glaucoma population, the nonparametric Spearman partial correlation was used, controlling the age factor between functional scores, QoL scores, and the performance of objective tasks. The level of statistical significance was defined as 0.05.

RESULTS

Comparison Between Groups
There were no sex or age differences between the 3 groups. The BCVA-BE was significantly higher in the CO group compared with the EG and AG groups (P = 0.0006 and 0.0045, respectively), but there was no difference between the EG
and AG groups. The BCVA-WE was significantly higher in the CO group compared with the EG group (P = 0.0147). The Esterman score was significantly higher in the AG group than in either the CO or EG groups (P = 0.0012 and 0.003, respectively). With regard to the MD-BE and MD-WE, the AG group had the lowest values compared with both the CO and EG groups (P < 0.001 for all comparisons). Similarly, the MD-BE and MD-WE were lower in the EG group compared with the CO group (P = 0.0115 and 0.001, respectively). There was no difference in binocular contrast sensitivity between the 3 groups. Demographic and visual function data are summarized in Supplemental Table 1 (Supplemental Digital Content 1, http://links.lww.com/IJG/A417).

For QoL, the GH score was not different between the 3 groups. The CS was significantly lower in the glaucoma groups compared with controls (P = 0.008 and 0.0015 for EG and AG, respectively). There was no difference between the EG and AG groups for the CS. The GV score was significantly lower in the AG group than in either the EG or CO groups (P = 0.0006 and 0.0188, respectively). Similarly, the GV score was lower in the EG compared with the CO group (P = 0.0135). With regard to the QoL subtype analyses, glaucoma patients showed significant differences compared with controls for NA, DA, MH, RD, and PV. Moreover, the AG group had significantly further decreased scores compared with normal subjects and the EG group for SF, Dp, and CV QoL subtypes. Results of the QoL analyses are presented in Supplemental Table 2 (Supplemental Digital Content 2, http://links.lww.com/IJG/A418).

With regard to performance in the simulated mobility task, no significant difference was found between groups for TP, but the number of MI was higher for the AG group than in the other 2 groups (P = 0.0126 and 0.0281, for CO and EG, respectively) and for the EG group compared with CO. For the reaching and grasping tasks, the MOL was longer in the AG group compared with the CO and the EG groups (P = 0.0207 and 0.0431, for CO and EG, respectively). The OMD.S was significantly longer in the glaucoma groups compared with CO (P = 0.0246 and 0.0193, for EG and AG, respectively). For the reaching and grasping tasks, errors were not analyzed, because they concerned only 2 patients within the glaucoma groups (representing only 0.62% of all trials). Results of simulated activities of daily living are presented in Supplemental Table 3 (Supplemental Digital Content 3, http://links.lww.com/IJG/A419).

Correlations Between QoL Scores and Visual Impairment

BCVA-BE was correlated with BCVA-WE (r = 0.63; P < 0.001), and, similarly, MD-BE was correlated with MD-WE (r = 0.55; P < 0.001). The Esterman score was correlated with both MD-BE and MD-WE (r = 0.40, P = 0.020 and r = 0.49, P = 0.202, respectively). MD-BE was correlated with the QoL subscores GV (r = 0.36, P = 0.037), SF (r = 0.46, P = 0.005), and CV (r = 0.38; P = 0.025). MD-WE was correlated with the CS (r = 0.40; P = 0.019) and most of the QoL subscores: GV (r = 0.55; P < 0.001), SF (r = 0.40; P = 0.019), MH (r = 0.46; P = 0.005), Dp (r = 0.37; P = 0.032), and CV (r = 0.37; P = 0.034). The Esterman score was significantly correlated with CV (r = 0.39; P = 0.022) and SF (r = 0.32; P = 0.072). Correlation results are presented in Supplemental Table 4 (Supplemental Digital Content 4, http://links.lww.com/IJG/A420).

Correlation Between QoL Scores and Performance in Simulated Activities of Daily Living

Within the mobility task, TP was only significantly correlated with DA (r = 0.39; P = 0.022). MI and the reaching and grasping task parameters were not significantly correlated with QoL scores. Within the simulated tasks, there were significant correlations between TP and MO.L (r = 0.43; P = 0.011), between MO.S and L (r = 0.66; P < 0.001), and between OMD.S and L (r = 0.88; P < 0.001). Correlation results are presented in Supplemental Table 5 (Supplemental Digital Content 5, http://links.lww.com/IJG/A421).

DISCUSSION

Consistently with previous studies, we showed an alteration in objective visual function and performance in activities of daily living, and decrease QoL in glaucoma patients compared with a control group of normal subjects.10,20 This result was obtained even though the patients included in our study presented with VA of at least 0.6 in each eye. Patients with AG also showed a significant decrease in QoL compared with patients with EG, particularly in terms of CV, Dp, SF, and GV. Although some studies have reported poor correlations between disease-specific QoL measures, such as the NEI VFQ-25 and VF changes,13,21,22 our results showed that glaucoma has a direct impact on patients’ QoL even at an early stage and that QoL decreases in accordance with the severity of glaucoma, as measured by VF testing.

Considering simulated activities of daily living, although the time to travel the mobility course (TP) was not different between groups, patients with AG showed poorer performance than either the EG patients or CO subjects, with more mobility incidents. These results are in accordance with previous studies showing almost no difference between controls and patients with early to moderate glaucoma, but differences appearing in more advanced stages of glaucoma.12,23 Turano et al,24 in a study enrolling a broad distribution of glaucoma stages, showed no difference in mobility incidents, but a decrease in velocity in glaucoma patients compared with controls. Contrarily, Popescu et al25 included more AG patients and observed a decrease in performance in glaucoma patients during locomotion and balance tasks compared with healthy subjects. In a previous study, we showed that the mobility task was more closely related to changes observed on binocular testing such as the Esterman VF than on monocular VF testing.9 Early glaucoma patients often showed no change in binocular VF, allowing for effective and unchanged mobility. As glaucoma progresses, both eyes may develop severe VF loss, leading to possible differences in performance on mobility tasks. Interestingly, in the present study, there was a correlation between the Esterman binocular VF score and the patients’ QoL, particularly in terms of social life (SF and Dp). This emphasizes the threshold effect on performance of severe binocular alterations compared with severe monocular alterations. Whereas the mobility task was only altered in AG patients, the reaching and grasping tasks were altered even in EG patients. The OMD.S was significantly higher in both EG and AG glaucoma patients. Similarly, Sippel et al13 showed that glaucoma patients took a longer time to find items in a supermarket than controls, and those who found objects had more glances toward the area of the VF defect. In a study by Smith et al,26 glaucoma patients also took significantly longer than controls for a visual search task on a computer and showed fewer saccades per second.

972 | www.glaucomajournal.com

Copyright © 2020 Wolters Kluwer Health, Inc. All rights reserved.

Copyright © 2020 Wolters Kluwer Health, Inc. All rights reserved.
Some authors have found that the impaired performance on visual search tasks may be attributed to the lack of peripheral information available to patients with peripheral VF loss.16,22 As PV provides critical wide-field information about the environment and brings targets into the fovea for high-resolution inspection, peripheral VF defects negatively impact visual search for objects28 and central near vision.19,20 This might explain our findings of deficient visual search tasks in both EG and AG patients.

Intuitively, as the binocular VF is determined mainly by the VF of the better eye, one might suspect that QoL in glaucoma patients would be correlated with visual function of the better eye. However, in the present study, the correlation analysis between QoL and visual function tests showed a positive correlation between most of the QoL subscores and the MD-WE. Murata et al31 previously created a QoL prediction system to correlate VF test points with vision-related QoL. These authors also found that the WE (BCVA-WE) was the most important parameter linked with vision-related QoL. These authors also found that the WE (BCVA-WE) was the most important parameter linked with vision-related QoL. These authors also found that the WE (BCVA-WE) was the most important parameter linked with vision-related QoL. These authors also found that the WE (BCVA-WE) was the most important parameter linked with vision-related QoL. These authors also found that the WE (BCVA-WE) was the most important parameter linked with vision-related QoL.

Takahashi et al33 found significant correlations between visual function tests and QoL scores in glaucoma patients, implying compensation of the better eye as a determinant of QoL. As previously mentioned, the relationship between QoL and glaucoma is complex and not simply related to visual function. Most studies have found only a modest correlation between NEI VFQ-25 scores and VF status in patients with glaucoma.10,32,34–36 Moreover, similarly to objective performance, a threshold effect might exist in the relationship between VF alteration and QoL impairment, as a report from the EMGT showed that many patients with VF loss of <50% in the better eye rated their vision-related QoL at a level similar to that reported by patients with no VF loss in the better eye.37

Meanwhile, we found no correlation between performance of simulated activities of daily living and QoL scores in this study. Both the NEI VFQ-25 and simulated activities of daily living have been shown to be valid measures of performance6: the latter tests the patient’s ability to perform an activity, while the former interprets the patient’s perception of his or her abilities. Some investigators have also evaluated the correlation between an objective evaluation of vision-specific ability to perform activities of daily living, clinical vision function tests, and QoL questionnaires.51,38,39 Interestingly, the results of binocular visual function tests have shown higher correlations with objective performance tests than with questionnaire scores.31,39 Our results, showing that QoL was related more to the visual function of the worse eye than the binocular visual function, might explain these results. During activities of daily living, the alteration in visual function of the worse eye is compensated for by the better eye, giving the patient more effective and less altered binocular vision. Consequently, there was no correlation between the ability to perform tasks and the QoL evaluation. These results also suggest that the Humphrey VF MD of the worse eye might serve as a good marker for QoL evaluation in glaucoma patients.

While this study has some limitations, including the small number of AG patients and the inclusion of patients with preserved VA in both eyes, our results show that EG patients display alterations in their QoL and/or their ability to perform activities of daily living. However, there is no clear correlation between alterations in QoL and ability to perform activities of daily living. These results clearly demonstrate that the impairment in QoL in glaucoma involves far more complex factors than simply altered visual function.

REFERENCES
1. Tham YC, Li X, Wong TY, et al. Global prevalence of glaucoma and projected number of glaucoma patients by 2040. Br J Ophthalmol. 2014;98:1037–1038.
2. Shon K, Wolfsung R, Schuman JS, et al. Prediction of glaucomatous visual field progression: pointwise analysis. Curr Eye Res. 2013;39:705–710.
3. Sousa MC, Betti LG, Doriaia R, et al. Suitability of the Visual Field Index according to glaucoma severity. J Curr Glaucoma Pract. 2015;9:65–68.
4. Oberg T, Jakobsen JE, Hultgren SI, et al. The impact of glaucoma on the quality of life of patients in Norway. II. Patient response correlated to objective data. Acta Ophthalmol Scand. 2001;79:121–124.
5. Quaratina L, Riva I, Gerardi C, Oddone F. Quality of life in glaucoma: a review of the literature. Adv Ther. 2016;33:959–981.
6. Brusini P, Johnson CA. Staging functional damage in glaucoma: review of different classification methods. Surv Ophthalmol. 2007;52:156–179.
7. Alqudah A, Mансberger SL, Gardiner SK, et al. Vision-related quality of life in glaucoma suspect or early glaucoma patients. J Glaucoma. 2016;25:629–633.
8. Floriani I, Quaratana L, Rulli E, et al. Health-related quality of life in patients with primary open-angle glaucoma. An Italian multicentre observational study. Acta Ophthalmol. 2016;94: e278–e286.
9. Lombardi M, Zenouda A, Azoulay-sebban L, et al. Correlation between visual function and simulated performance of daily living activities in glaucomatous patients. J Glaucoma. 2018;27:1017–1024.
10. Hyman LG, Komaroff F, Heijl A, et al. Early Manifest Glaucoma Trial Group. Treatment and vision-related quality of life in the early manifest glaucoma trial. Ophthalmology. 2005;112:1505–1513.
11. Spathet G, Walt J, Keener J. Evaluation of quality of life for patients with glaucoma. Am J Ophthalmol. 2006;141:S3–S14.
12. Nelson P, Aspinall P, O’Brien C. Patients’ perception of visual impairment in glaucoma: a pilot study. Br J Ophthalmol. 1999;83:546–552.
13. Sippel K, Kasneci E, Aehling K, et al. Binocular glaucomatous visual field loss and its impact on visual exploration—a super market study. PLoS One. 2014;9:e106089.
14. McGwin G Jr, Huisingh C, Jain SG, et al. Binocular visual field impairment in glaucoma and at-fault motor vehicle collisions. J Glaucoma. 2015;24:138–143.
15. Lisboa R, Chun YS, Zangwill LM, et al. Association between rates of binocular visual field loss and vision-related quality of life in patients with glaucoma. JAMA Ophthalmol. 2013;131:486–494.
16. Esterman DB. Functional scoring of the binocular visual field. Ophthalmology. 1982;89:1226–1234.
17. Susanna R, Vessani RM. Staging glaucoma patient: why and how? Open Ophthalmol J. 2009;3:59–64.
18. Nordmann JP, Viñas M, Sullivan K, et al. Psychometric validation of the “National Eye Institute Visual Function Questionnaire-25 (NEI VFQ-25)” French version in a population of patients treated for ocular hypertension and glaucoma. Pharmacoeconomics. 2004;22:197–206.
19. Suzukamo Y, Oshika T, Yuzawa M, et al. Psychometric properties of the 25-item National Eye Institute Visual Function Questionnaire (NEI VFQ-25), Japanese version. Health Qual Life Outcomes. 2005;3:65.

20. Ekici F, Loh R, Waisbourd M, et al. Relationships between measures of the ability to perform vision-related activities, vision-related quality of life, and clinical findings in patients with glaucoma. JAMA Ophthalmol. 2015;133:1377–1385.

21. Janz NK, Wren PA, Lichter PR, et al. Quality of life in newly diagnosed glaucoma patients: the Collaborative Initial Glaucoma Treatment Study. Ophthalmology. 2001;108:887–897.

22. Mills RP, Janz NK, Wren PA, et al. Correlation of visual field with quality-of-life measures at diagnosis in the Collaborative Initial Glaucoma Treatment Study (CIGTS). J Glaucoma. 2001;10:192–198.

23. Viswanathan AC, McNaught AI, Poinoosawmy D, et al. Severity and stability of glaucoma: patient perception compared with objective measurement. Arch Ophthalmol. 1999;117:450–454.

24. Turano KA, Rubin GS, Quigley HA. Mobility performance in glaucoma. Invest Ophthalmol Vis Sci. 1999;40:2803–2809.

25. Popescu ML, Boisjoly J, Schmaltz H, et al. Age-related eye disease and mobility limitations in older adults. Invest Ophthalmol Vis Sci. 2011;52:7168–7174.

26. Smith ND, Glen FC, Crabb DP. Eye movements during visual search in patients with glaucoma. BMC Ophthalmol. 2012;12:12–45.

27. Dakin S, Fiser J, Pasquale LR, et al. Effects of peripheral visual field loss on eye movements during visual search. Front Psychol. 2012;3:1–13.

28. Smith ND, Crabb DP, Garway-Heath DF. An exploratory study of visual search performance in glaucoma. Ophthal Physiol Opt. 2011;31:225–232.

29. Ramulu P. Glaucoma and disability: which tasks are affected, and at what stage of disease? Curr Opin Ophthalmol. 2009;20:92–98.

30. Richman J, Lorenzana LL, Lankaranian D, et al. Relationships in glaucoma patients between standard vision tests, quality of life, and ability to perform daily activities. Ophthalmic Epidemiol. 2010;17:144–151.

31. Murata H, Hirasawa H, Aoyama Y, et al. Identifying areas of the visual field important for quality of life in patients with glaucoma. PLoS One. 2013;8:e58695.

32. van Gestel A, Webers CAB, Beckers HJM, et al. The relationship between visual field loss in glaucoma and health-related quality-of-life. Eye. 2010;24:1759–1769.

33. Takahashi G, Otori Y, Urashima M, et al. Quality of Life Improvement Committee. Evaluation of quality of life in Japanese glaucoma patients and its relationship with visual function. J Glaucoma. 2016;25:e150–e156.

34. Gutierrez P, Wilson MR, Johnson C, et al. Influence of glaucomatous visual field loss on health-related quality of life. Arch Ophthalmol. 1997;115:777–784.

35. Parrish RK, Gedde SJ, Scott IU, et al. Visual function and quality of life among patients with glaucoma. Arch Ophthalmol. 1997;115:1447–1455.

36. Sumi I, Shirato S, Matsumoto S, et al. The relationship between visual disability and visual field in patients with glaucoma. Ophthalmology. 2003;110:332–339.

37. Peters D, Heijl A, Brenner L, et al. Visual impairment and vision-related quality of life in the Early Manifest Glaucoma Trial after 20 years of follow-up. Acta Ophthalmol. 2015;93:745–752.

38. Chelsea LR, Manju RP, Sujani S, et al. Glaucoma-associated visual task performance and vision-related quality of life in South India. Ophthalmol Glaucoma. 2019;2:357–363.

39. Sun Y, Lin C, Waisbourd M, et al. The impact of visual field clusters on performance-based measures and vision-related quality of life in patients with glaucoma. Am J Ophthalmol. 2016;163:45–52.