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Dry eye specific quality of life in veterans using glaucoma drops

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Abstract

Purpose—To evaluate the frequency of ocular surface symptoms and their potential impact on dry eye specific quality of life (QoL) in patients using versus not using glaucoma medications.

Material and methods—The study was a single-center, cross-sectional survey of patients seen at the Miami Veterans Affairs (VA) ophthalmology and optometry clinics from June to August, 2010. Patients were invited to complete the Dry Eye Questionnaire 5 (DEQ5) and the Impact of Dry Eye on Everyday Life (IDEEL) at their visit. Of 1348 patients seen in the Miami VA eye clinics during this three-month period, 467 patients completed the DEQ5 and 391 responded to both questionnaires. Outcome measures comprised ocular surface symptoms and their impact on dry eye specific QoL in patients using versus not using glaucoma drops.

Results—An increasing number of glaucoma drops was significantly associated with an increased percentage of severe dry eye symptoms: no medications, 25% ($n = 89/353$); 1 or 2 medications, 27% ($n = 17/62$); 3 or more medications, 40% ($n = 21/52$); $p = 0.03$ (Armitage's test for linear-trend in proportions). There was an association between increasing number of drops and decreasing emotional well-being scores (linear $p < 0.001$; quadratic $p = 0.029$). Black patients had higher dry eye symptoms and lower emotional QoL scores compared to white patients at every level of medication use.

Conclusion—An increasing number of glaucoma medications were associated with an increased frequency of severe dry eye symptoms and decreased emotional QoL. Additionally, dry eye specific emotional QoL was more severely affected in black versus white patients.

Keywords

Quality of life; Dry eye syndrome; Glaucoma

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Conflicts of Interest

None of the authors have any conflicts of interest to disclose.

1. Introduction

Glaucoma and dry eye are prevalent conditions that often coexist in patients [1]. Glaucoma affects more than 60 million people worldwide and even mild disease has a significant impact on quality of life (QoL) [2,3]. Dry eye affects between 5 and 30% of the population aged 50 and older [4,5] and can also be associated with significant morbidity [6]. Its symptoms of discomfort and blurred vision impact the ability to work and carry out activities of daily living and affect emotional health [6–8]. Dry eye or ocular surface disease (OSD) in the glaucoma patient is a multifactorial disorder that is in part due to the myriad side effects of topical glaucoma medication [1,9,10].

Several studies have found a high frequency of dry eye symptoms in patients using glaucoma medications [6,9,11–17]. Using the ocular surface disease index (OSDI) as a measure of dry eye severity, approximately ¼ of patients using glaucoma drops complained of severe symptoms [9,10,14,16]. Furthermore, glaucoma medication use and its associated dry eye symptoms have been shown to affect QoL. Using both the National Eye Institute Visual Function Questionnaire (NEI-VFQ) (a non-specific vision-related quality of life metric) [12,18] and the Glaucoma Quality of Life-15 (GQL-15) (tailored to glaucoma patients, asking questions about vision, dark adaptation/glare, and mobility) [10,20], studies have found that the use of glaucoma medications and dry eye symptoms both have a negative effect on QoL. Furthermore, more severe glaucoma status also correlated with decreased QoL using these metrics [10,19]. In contrast to the NEI-VFQ and the GQL-15, the Impact of Dry Eye on Everyday Life (IDEEL) questionnaire (Alcon, Fort Worth, TX) is a newer metric that measures dry eye specific QoL [20], and therefore is theoretically less dependent on glaucoma severity when estimating the effect of dry eye symptoms on QoL.

We have previously demonstrated that dry eye is a prevalent condition in the Miami Veteran Affairs (VA) population [21,22] and have assessed dry eye symptoms and QoL metrics in this population with the 5-Item Dry Eye Questionnaire (DEQ5) and IDEEL [6]. In this study, we aimed to build on these results and evaluate how the presence of glaucoma drops affected the presence of dry eye symptoms and subsequently dry eye specific QoL. Furthermore, given our multi-racial population, we were in a unique position to evaluate how demographic factors modulated QoL scores in those using glaucoma drops. This latter information is important as an enhanced understanding of factors that impact QoL can lead to tailored algorithms that will increase patient adherence and thereby improve treatment outcomes.

2. Methods

2.1. Study population

The Miami Veterans Affairs (VA) ophthalmology and optometry eye clinics serve veterans with specific eye problems along with those needing surveillance due to medical conditions (e.g. diabetes). Patients seen in the Miami VA eye clinic between June and August, 2010 were invited to complete two questionnaires at the time of their visit, first the DEQ5 and then the IDEEL. The questionnaires were self-administered without assistance. No patients were excluded from participation as our intention was to ascertain the burden of ocular

surface symptoms in a broad group of eye care patients. Of 1348 patients seen in the Miami VA eye clinic during the three-month period, 467 patients (35%) self-administered the DEQ5 and 391 (29%) filled out both the DEQ5 and the IDEEL. To evaluate potential biases associated with incomplete patient ascertainment, demographic characteristics of non-responders were collected bi-monthly (every other Friday). Using Student's *t*-test and chi square analysis, no demographic differences in age, gender, race (black/white) and ethnicity (Hispanic (H)/non-H) were found between those that did and did not fill out the questionnaires.

2.2. Determination of severity of ocular surface symptoms

The DEQ5 is a dry eye specific questionnaire consisting of five questions regarding the presence and severity of eye discomfort, dryness, and tearing over a one-month recall period [23]. The score ranges from 0 to 22, with 0 reflecting no ocular surface symptoms and 22 reflecting a large number of symptoms. Per previously established guidelines, mild to moderate ocular surface symptoms were defined as a DEQ5 score between 6 and 11 and severe ocular surface symptoms was defined as a score of 12 or greater [23].

2.3. Measurement of quality of life

The IDEEL is a questionnaire that assesses QoL specific to dry eye [8]. The 27-item QoL module is divided into three sections, which measure daily activity limitations, emotional well-being, and work limitations. The questionnaire asks, "Over the last two weeks, how limited were you in doing the following activities BECAUSE OF YOUR DRY EYES?" followed by 27 statements including limitations to driving (activities of daily living), feeling sad (emotion), and having to change the way you work (work). For each of these three domains, a scale score is calculated between 0 (representing total impairment) and 100 (representing no impairment).

2.4. Data collection

The VA ophthalmology service initiated this study as a quality improvement project. Miami VA Institutional Review Board review and approval was later obtained to perform a chart review and link patient data to the questionnaires. The study was conducted in accordance with the principles of the Declaration of Helsinki. Data from the two questionnaires were collected at the time of the respondents' visit and entered into a standardized database. The Veterans Affairs administrative database was used to collect other data including demographic information (age, gender, race, ethnicity), past ocular and medical history (by chart review and by using the International Classification of Disease codes (ICD9)), and medication use (by chart review of reported medication and medication order history).

2.5. Determination of glaucoma severity

For all patients in the glaucoma group, visual fields were individually looked at and classified according to the most recent ICD-9/ICD-10 staging codes for glaucoma severity [24,25]. Per guidelines, glaucoma severity were classified by assessing the field in the most severely affected eye: (1) mild or early-stage glaucoma if there were no visual field abnormalities on white-on-white visual field test, (2) moderate-stage glaucoma if there was

visual field abnormality in one hemifield but not within 5 degrees of fixation, and (3) severe-stage glaucoma if there were visual field abnormality in both hemifields and/or loss within 5 degrees of fixation in at least one hemifield. Patients in whom a visual field was not possible (due to mental status or physical inability) or where there was a confounding ocular condition that made the visual field un-interpretable (severe macular degeneration, ischemic optic neuropathy, central retinal vein occlusion) were classified as indeterminate. Visual fields were done in most cases within one year of the date of the patient questionnaire.

2.6. Main outcome measures

The main outcome measures include ocular surface symptoms and their associated impact on dry eye specific QoL in patients using glaucoma medications compared to control patients not on such medications. The effect of potential confounders, such as demographic characteristics, glaucoma severity, and co-morbid conditions, was evaluated. As glaucoma medications are known to increase dry eye symptoms and severity, we hypothesized that these symptoms would negatively impact dry eye specific QoL, independent of glaucoma severity.

2.7. Statistical analysis

All statistical analyses were performed using SPSS 22.0 (SPSS Inc, Chicago, IL) statistical package. Categorical values were compared using chi square analysis; continuous variables were compared using the independent Student's *t*-test (for normally distributed variables: age, DEQ5, activity and work QoL scores) and Mann-Whitney test (for non-normally distributed variable: emotional QoL). Multiple logistic regression was used to examine the relationship between presence of severe ocular surface symptoms and gender, age, ethnicity, number of glaucoma medications, and other influential covariates. A separate slopes and intercepts regression was performed with emotional QoL score as the dependent variable and linear and quadratic terms for centered number of glaucoma drops as the independent variables. Multivariable linear regression was applied to evaluate the effects of demographics, glaucoma severity, systemic co-morbidities and medication use on dry eye specific emotional QoL scores. With 300 subjects, 40% of which had black race, this study had 89% power to detect a 10 point difference in mean IDEEL emotion score with the two sample *t*-test and alpha of 0.05. We also use linear regression analysis and our sample size gave us more than 90% power to find moderately sized effects ($f^2 = 0.15$) with a five predictor model.

3. Results

3.1. Study population

In our cohort, 353 control patients (patients not using glaucoma medications) and 114 cases (patients using glaucoma medications) completed either the DEQ5 alone ($n = 467$) or both the DEQ5 and IDEEL ($n = 391$). Patients on glaucoma medications received a homogeneous mix of medications. Based on the national VA formulary, all patients on a topical beta-blocker were on generic timolol 0.5%, all patients on an alpha-agonist were receiving generic brimonidine 0.2%, all patients on a prostaglandin analog were receiving Travatan Z (Travaprost, Alcon, Fort Worth, TX), and all patients receiving combination therapy were on

generic dorzolamide 2%/timolol 0.5%. For statistical analysis, combination drops were considered as two separate medications. Other topical glaucoma medications were not used in this population and all drops were BAK-containing with the exception of the prostaglandin analog travoprost.

No significant differences were noted with regards to age, gender, and ethnicity (non-Hispanic vs Hispanic) in those using and not using glaucoma medications (Table 1). Both white and black patients were more likely to not use glaucoma drops than use glaucoma drops (85% and 61% vs 15% and 40%, respectively, $p < 0.0005$). Black patients were more likely than white patients to use glaucoma medications (40% vs 15%, $p < 0.0005$). More patients on glaucoma drops had a visual acuity of 20/200 or worse in one eye compared to those not on drops (21% ($n = 23$) vs 8% ($n = 29$), $p < 0.0005$). There was no difference in the frequency of 20/200 or worse vision in both eyes between the two groups.

3.2. Ocular surface symptoms

Thirty-three percent of patients on glaucoma drops ($n = 38/114$) had severe ocular surface symptoms (defined as a DEQ5 score 12 or greater) compared to 25% in those not using glaucoma medications ($n = 89/353$), $p = 0.09$ (Table 2). In subgroup analysis, black patients were more likely than white patients to report severe ocular surface symptoms, both when using glaucoma drops (40% vs 20%, $p = 0.04$) and when not, although the latter difference was not statistically significant (34% vs 22%, $p = 0.09$) (Fig. 1). An increasing number of glaucoma medications was significantly associated with an increased percentage of severe dry eye symptoms: no medications, 25% ($n = 89/353$); 1 or 2 medications, 27% ($n = 17/62$); 3 or more medications, 40% ($n = 21/52$); $p = 0.03$ (Armitage's test for linear-trend in proportions) (Fig. 2). In a multivariable analysis including demographics, ocular and systemic co-morbidities, and medication use, black race, a history of dry eye, use of anti-depressants, and use of anti-histamines remained significant predictors of severe symptoms (Table 3).

3.3. Quality of life implications

391 patients completed both the DEQ5 and all or part of the IDEEL questionnaire; of those 391, glaucoma drop history was obtained from 373. Only 205 patients completed the work limitations section of the IDEEL as the others were not actively working. Patients on glaucoma medications had significantly lower dry eye specific emotional well-being scores compared to those not on glaucoma medications (77 standard deviation (SD) 27 vs 85 SD 22, $p = 0.02$). No differences in dry eye specific QoL scores were noted between groups with regards to the capacity to work and perform activities of daily living (Table 2). There was a negative association between increasing number of topical medications and decreasing dry eye specific emotional well-being scores (linear $p < 0.001$; quadratic $p = 0.029$) (Fig. 3). We compared the IDEEL Emotional Score in blacks versus whites and by number of glaucoma drops used with a two way analysis of variance in which black race and number of drops were factors. The difference between the races was significant ($p = 0.001$), the difference between number of drops was significant ($p = 0.019$), and there was no significant interaction between race and number of drops ($p = 0.13$). The relationship between number of drops, IDEEL score, and race is graphically depicted in Fig. 3.

Black race remained a significant predictor of lower dry eye specific emotional QoL scores when systemic diagnosis such as depression and post-traumatic stress disorder, the use of anti-anxiety/anti-depression/anti-histamine medications, and visual acuity were considered. Because more than half the subjects reported an emotional score of 100%, in a secondary analysis, we separated subjects into two groups: those who scored 100% and those who scored less than 100%. More white patients than black patients reported emotion scores of 100% (34% vs 47%, $p = 0.019$). Among subjects with emotion scores $<100\%$, multiple regression analysis found that both increasing number of glaucoma meds ($p < 0.001$) and black race ($p = 0.048$) were associated with lower emotion scores. Gender, age, ethnicity (non-Hispanic vs Hispanic), and the presence of diabetes mellitus did not differentially affect dry eye specific emotional QoL scores in our population. Furthermore, in those patients with visual field information, the degree of visual field loss did not predict dry eye specific emotional health.

4. Discussion

Our findings corroborate those of previous studies and demonstrate that dry eye symptoms are more common in patients using glaucoma drops, with an increased frequency of severe symptoms in those using more drops. Specifically, our finding that approximately a third of patients on glaucoma drops complained of severe symptoms (by DEQ5 metric) is in line with previous frequency estimates of severe symptoms in 20–27% (by OSDI metric) [9,14,16]. Unique to our study was the assessment of dry eye specific QoL in patients using glaucoma medications. As the IDEEL was developed to assess dry eye specific QoL, we were able to evaluate the effect of glaucoma medications on dry eye specific QoL irrespective of the severity of glaucoma. Indeed our findings were not altered when glaucoma severity was considered as a potential confounder. This is an important distinction from prior studies that have utilized non-dry eye specific QoL measures [10,12,18]. We infer that lower dry eye associated emotional scores in those using drops could impact patient adherence. Indeed, several studies have found that side effects are cited by patients as one reason for medication non-adherence [26–29].

When assessing which additional factors, besides the use of glaucoma medications, modulate QoL, we found that black patients more frequently complained of severe symptoms and lower emotional QoL scores than white patients. While the driving force behind our findings is unknown and undoubtedly complex, this is an important avenue for future study. It is well known that glaucoma affects the black population disproportionately when compared to the white population [30], and black patients are 15 times more likely to be visually impaired from glaucoma than white patients [31]. Data from Collaborative Initial Glaucoma Treatment Study (CIGTS) suggests that black patients may also have more visual field progression than white counterparts given the same treatments [32]. This may be related to issues of non-adherence, as multiple studies have demonstrated lower adherence to glaucoma medications in black patients [33–35], although this is not a uniform finding [36]. As expected, poor adherence with glaucoma medications is associated with visual field progression [37,38]. Future studies will be needed to validate our findings in other populations and assess the effect of glaucoma medications by race using other QoL instruments.

Outside of glaucoma, health care disparities between black and white populations have been demonstrated in various other disciplines as well [30,39–42]. For example, hypertension affects a larger proportion of the black population. More importantly, control of hypertension has been demonstrated to be poorer for black patients even when adjusted for socioeconomic status, other medical conditions, and antihypertensive medications [39]. Similar differences have been found in the treatment of chronic pain, pneumonia, and osteoarthritis in a VA population [22,42]. As with our findings, it is not clear why such disparities exist. However, studying and addressing potential factors may lead to increased medication adherence and improved clinical outcomes. In fact, in the case of glaucoma medication adherence, a recent program promoting adherence in black patients specifically addresses medication side effects as one of the top five barriers to adherence [29].

Like all studies, our results must be considered bearing in mind the study limitations. It is important to remember that our methodology relied on patient self-report of ocular surface symptoms and associated limitations in physical and mental functioning. Furthermore, not all patients elected to fill out one or both questionnaires and some patients may not have been able to complete questionnaires due to visual limitations. While we purposefully chose outcome measures that were not directly dependent on response rate, dry eye specific QoL scores may have been different in non-responders compared to responders. In addition, patient responses may have been influenced by other confounding variables about which we did not have information, such as smoking, socioeconomic status, concomitant dry eye treatment, and a history of glaucoma surgery. We also had a proportionately higher percentage of black patients in our study using glaucoma medications than in the general population. We estimate that this is due to the higher prevalence of glaucoma in the black population as a whole, but perhaps also a higher than expected proportion of black veterans that receive care in the setting of a veterans hospital. Regarding medication use, we considered the total number of glaucoma medications used and did not further classify medications according to the presence of preservatives or daily dosing (i.e. two or three times daily). For statistical analysis, we chose not to adjust *p*-values for multiple testing as this is known to increase the beta error. Rather we presented all comparisons performed so that the reader knows how many tests we performed [43–46]. Lastly, our findings may not be generalizable to other U.S. populations because of differences in the population studied, Miami's climate, and other measures.

With these limitations in mind, this is the first study to evaluate the impact of glaucoma medications on dry eye specific QoL and the first to report racial differences with regards to this metric. We found a large disparity in dry eye symptoms and dry eye related emotional QoL between black and white respondents that cannot be explained solely by the presence of ocular surface symptoms. This finding highlights the need to consider QoL implications when prescribing glaucoma medications and to investigate factors that mitigate the negative impact of these medications on patients. Research on this topic has the potential to improve treatment response and decrease morbidity in this often debilitating disease.

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References

1. Anwar Z, Wellik SR, Galor A. Glaucoma therapy and ocular surface disease: current literature and recommendations. *Curr Opin Ophthalmol*. 2013; 24:136–43. [PubMed: 23542350]
2. Varma R, Lee PP, Goldberg I, Kotak S. An assessment of the health and economic burdens of glaucoma. *Am J Ophthalmol*. 2011; 152:515–22. [PubMed: 21961848]
3. Quigley HA, Broman AT. The number of people with glaucoma worldwide in 2010 and 2020. *Br J Ophthalmol*. 2006; 90:262–7. [PubMed: 16488940]
4. The epidemiology of dry eye disease: report of the Epidemiology Subcommittee of the International Dry Eye WorkShop (2007). *Ocular Surf*. 2007; 5:93–107.
5. Brewitt H, Sistani F. Dry eye disease: the scale of the problem. *Surv Ophthalmol*. 2001; 45(Suppl 2):S199–202. [PubMed: 11587143]
6. Pouyeh B, Viteri E, Feuer W, et al. Impact of ocular surface symptoms on quality of life in a United States veterans affairs population. *Am J Ophthalmol*. 2012; 153:1061, e3–6e3. [PubMed: 22330309]
7. Schiffman RM, Walt JG, Jacobsen G, Doyle JJ, Lebovics G, Sumner W. Utility assessment among patients with dry eye disease. *Ophthalmology*. 2003; 110:1412–9. [PubMed: 12867401]
8. Rajagopalan K, Abetz L, Mertzanis P, et al. Comparing the discriminative validity of two generic and one disease-specific health-related quality of life measures in a sample of patients with dry eye. *Value Health*. 2005; 8:168–74. [PubMed: 15804325]
9. Leung EW, Medeiros FA, Weinreb RN. Prevalence of ocular surface disease in glaucoma patients. *J Glaucoma*. 2008; 17:350–5. [PubMed: 18703943]
10. Skalicky SE, Goldberg I, McCluskey P. Ocular surface disease and quality of life in patients with glaucoma. *Am J Ophthalmol*. 2012; 153:1, e2–9e2. [PubMed: 21872203]
11. Fechtner RD, Godfrey DG, Budenz D, Stewart JA, Stewart WC, Jasek MC. Prevalence of ocular surface complaints in patients with glaucoma using topical intraocular pressure-lowering medications. *Cornea*. 2010; 29:618–21. [PubMed: 20386433]
12. Rossi GC, Tinelli C, Pasinetti GM, Milano G, Bianchi PE. Dry eye syndrome-related quality of life in glaucoma patients. *Eur J Ophthalmol*. 2009; 19:572–9. [PubMed: 19551671]
13. Pisella PJ, Pouliquen P, Baudouin C. Prevalence of ocular symptoms and signs with preserved and preservative free glaucoma medication. *Br J Ophthalmol*. 2002; 86:418–23. [PubMed: 11914211]
14. Costa VP, Marcon IM, Galvao Filho RP, Malta RF. The prevalence of ocular surface complaints in Brazilian patients with glaucoma or ocular hypertension. *Arq Bras Oftalmol*. 2013; 76:221–5. [PubMed: 24061832]
15. Baudouin C, Renard JP, Nordmann JP, et al. Prevalence and risk factors for ocular surface disease among patients treated over the long term for glaucoma or ocular hypertension. *Eur J Ophthalmol*. 2013; 23(1):47–54.
16. Garcia-Feijoo J, Sampaioles JR. A multicenter evaluation of ocular surface disease prevalence in patients with glaucoma. *Clin Ophthalmol*. 2012; 6:441–6. [PubMed: 22536034]
17. Ghosh S, O'Hare F, Lamoureux E, Vajpayee RB, Crowston JG. Prevalence of signs and symptoms of ocular surface disease in individuals treated and not treated with glaucoma medication. *Clin Exp Ophthalmol*. 2012; 40:675–81. [PubMed: 22394358]
18. Rossi GC, Pasinetti GM, Scudeller L, Bianchi PE. Ocular surface disease and glaucoma: how to evaluate impact on quality of life. *J Ocular Pharmacol Ther*. 2013; 29:390–4.
19. Ringsdorf L, McGwin G Jr, Owsley C. Visual field defects and vision-specific health-related quality of life in African Americans and whites with glaucoma. *J Glaucoma*. 2006; 15:414–8. [PubMed: 16988604]
20. Abetz L, Rajagopalan K, Mertzanis P, Begley C, Barnes R, Chalmers R. Development and validation of the impact of dry eye on everyday life (IDEEL) questionnaire, a patient-reported

outcomes (PRO) measure for the assessment of the burden of dry eye on patients. *Health Qual Life Outcomes*. 2011; 9:111. [PubMed: 22152125]

21. Galor A, Feuer W, Lee DJ, et al. Prevalence and risk factors of dry eye syndrome in a United States veterans affairs population. *Am J Ophthalmol*. 2011; 152:377, e2–84e2. [PubMed: 21684522]
22. Galor A, Feuer W, Lee DJ, et al. Depression post-traumatic stress disorder, and dry eye syndrome: a study utilizing the National United States Veterans Affairs Administrative Database. *Am J Ophthalmol*. 2012; 154:340, e2–6e2. [PubMed: 22541654]
23. Chalmers RL, Begley CG, Caffery B. Validation of the 5-Item Dry Eye Questionnaire (DEQ-5): discrimination across self-assessed severity and aqueous tear deficient dry eye diagnoses. *Cont Lens Anterior Eye*. 2010; 33:55–60. [PubMed: 20093066]
24. Escorpizo R, Kostanjsek N, Kennedy C, Nicol MM, Stucki G, Ustun TB. Harmonizing WHO's International Classification of Diseases (ICD) and International Classification of Functioning, Disability and Health (ICF): importance and methods to link disease and functioning. *BMC Public Health*. 2013; 13:742. [PubMed: 23938048]
25. ICD-10 means better documentation is a must. *Hosp Case Manag*. 2013; 21:113–4. [PubMed: 23923528]
26. Taylor SA, Galbraith SM, Mills RP. Causes of non-compliance with drug regimens in glaucoma patients: a qualitative study. *J Ocular Pharmacol Therap*. 2002; 18:401–9.
27. Djafari F, Lesk MR, Harasymowycz PJ, Desjardins D, Lachaine J. Determinants of adherence to glaucoma medical therapy in a long-term patient population. *J Glaucoma*. 2009; 18:238–43. [PubMed: 19295380]
28. Park MH, Kang KD, Moon J. Korean Glaucoma Compliance Study Group. Non-compliance with glaucoma medication in Korean patients: a multicenter qualitative study. *Jpn J Ophthalmol*. 2013; 57:47–56. [PubMed: 23065047]
29. Dreer LE, Girkin CA, Campbell L, Wood A, Gao L, Owsley C. Glaucoma medication adherence among African Americans: program development. *Optom Vision Sci*. 2013; 90:883–97.
30. Sommer A, Tielsch JM, Katz J, et al. Racial differences in the cause-specific prevalence of blindness in east Baltimore. *N Engl J Med*. 1991; 325:1412–7. [PubMed: 1922252]
31. Munoz B, West SK, Rubin GS, et al. Causes of blindness and visual impairment in a population of older Americans: The Salisbury Eye Evaluation Study. *Arch Ophthalmol*. 2000; 118:819–25. [PubMed: 10865321]
32. Burr J, Azuara-Blanco A, Avenell A, Tuulonen A. Medical versus surgical interventions for open angle glaucoma. *Cochrane Database Syst Rev*. 2012; 9:CD004399.
33. Friedman DS, Okeke CO, Jampel HD, et al. Risk factors for poor adherence to eyedrops in electronically monitored patients with glaucoma. *Ophthalmology*. 2009; 116:1097–105. [PubMed: 19376591]
34. Dreer LE, Girkin C, Mansberger SL. Determinants of medication adherence to topical glaucoma therapy. *J Glaucoma*. 2012; 21:234–40. [PubMed: 21623223]
35. Chang DS, Friedman DS, Frazier T, Plyler R, Boland MV. Development and validation of a predictive model for nonadherence with once-daily glaucoma medications. *Ophthalmology*. 2013; 120:1396–402. [PubMed: 23541760]
36. Ung C, Zhang E, Alfaro T, et al. Glaucoma severity and medication adherence in a county hospital population. *Ophthalmology*. 2013; 120:1150–7. [PubMed: 23453512]
37. Rossi GC, Pasinetti GM, Scudeller L, Radaelli R, Bianchi PE. Do adherence rates and glaucomatous visual field progression correlate? *Eur J Ophthalmol*. 2011; 21:410–4. [PubMed: 21140373]
38. Sleath B, Blalock S, Covert D, et al. The relationship between glaucoma medication adherence, eye drop technique, and visual field defect severity. *Ophthalmology*. 2011; 118:2398–402. [PubMed: 21856009]
39. Delgado J, Jacobs EA, Lackland DT, Evans DA, de Leon CF. Differences in blood pressure control in a large population-based sample of older African Americans and non-Hispanic whites. *J Gerontol A: Biol Sci Med Sci*. 2012; 67:1253–8. [PubMed: 22496537]

40. Hooten WM, Knight-Brown M, Townsend CO, Laures HJ. Clinical outcomes of multidisciplinary pain rehabilitation among African American compared with Caucasian patients with chronic pain. *Pain Med.* 2012; 13:1499–508. [PubMed: 22994358]
41. Kosoko-Lasaki O, Olivier MM. African American health disparities: glaucoma as a case study. *Int Ophthalmol Clin.* 2003; 43:123–31. [PubMed: 14574206]
42. Spruill TM, Gerber LM, Schwartz JE, Pickering TG, Ogedegbe G. Race differences in the physical and psychological impact of hypertension labeling. *Am J Hypertens.* 2012; 25:458–63. [PubMed: 22258335]
43. Saville DJ. Basic statistics and the inconsistency of multiple comparison procedures. *Revue Canadienne de Psychologie Experimentale.* 2003; 57:167–75. [PubMed: 14596475]
44. Perneger TV. What's wrong with Bonferroni adjustments. *BMJ.* 1998; 316:1236–8. [PubMed: 9553006]
45. O'Brien PC. The appropriateness of analysis of variance and multiple-comparison procedures. *Biometrics.* 1983; 39:787–94. [PubMed: 6652209]
46. Altman DG. Statistics in medical journals: some recent trends. *Stat Med.* 2000; 19:3275–89. [PubMed: 11113959]

Fig. 1. Frequency of severe dry eye symptoms (percent with Dry Eye Questionnaire 5 scores ≥ 12) stratified by glaucoma medication use and race.

Fig. 2.
Frequency of severe dry eye symptoms associated with number of glaucoma drops used.

Fig. 3. Emotional QoL scores of white versus black patients using different numbers of glaucoma medications.

Table 1

Demographic characteristics and medical history of the study population.

	Using glaucoma medications	Not using glaucoma medications	<i>P</i> -value
Number	114	353	
Age	68 ± 11	65 ± 13	0.06
Gender			
Male % (<i>n</i>)	97% (109)	94% (323)	0.26
Race			
White % (<i>n</i>)	15% (40)	85% (222)	<0.0005
Black % (<i>n</i>)	40% (62)	61% (95)	
Ethnicity			
Hispanic % (<i>n</i>)	14 (22%)	95 (25%)	0.56
Depression	39% (41)	40% (136)	0.83
Post-traumatic stress disorder	11% (12)	11% (37)	0.89
Anti-anxiety medication	13% (14)	18% (62)	0.23
Anti-depressant medication	21% (22)	26% (89)	0.27
Anti-histamine medication	24% (25)	31% (104)	0.17
Diabetes mellitus % (<i>n</i>)	36% (40)	39% (134)	0.49
Vision			
20/200 or less in one eye % (<i>n</i>)	21% (23)	8% (29)	<0.0005
20/200 or less in both eyes % (<i>n</i>)	1% (1)	0.6% (2)	
Visual field loss			
None % (<i>n</i>)	8% (9)	NA	
Mild–moderate	12% (13)		
Severe	73% (81)		
Indeterminate	6% (7)		

Table 2

Ocular surface symptoms (determined by DEQ5 score) and DES specific quality of life assessment (determined by IDEEL score) in patients using glaucoma medications compared to patients not using glaucoma medication.

Category	With glaucoma medications	Without glaucoma medications	P-value
Number completing DEQ5	114	353	
DEQ5 score	8.6 ± 5.1 (114)	7.9 ± 5.2 (353)	0.24
% (<i>n</i>) with DEQ5 > 11 (severe symptoms)	33% (38)	25% (89)	0.09
Subgroups			
Black (<i>n</i>)	40% (25)	34% (32)	
White (<i>n</i>)	20% (8)	22% (79)	
Number completing any IDEEL section	95	278	
Emotional well-being (<i>n</i>)	77 ± 27 (95)	85 ± 22 (277)	0.02
Activities performance (<i>n</i>)	84 ± 21 (95)	86 ± 18 (278)	0.40
Capacity to work (<i>n</i>)	85 ± 23 (52)	85 ± 23 (147)	0.89

DEQ5 = Dry Eye Questionnaire 5; DES = dry eye syndrome; IDEEL = Impact of Dry Eye on Everyday Life.

Table 3

Factors significantly associated with severe ocular surface symptoms (DEQ5 > 11) in a multivariable analysis.

Variable ^a	Odds ratio	95% CI	P-value
History of DE diagnosis	2.34	1.13–4.85	0.02
Black race (vs white)	2.14	1.35–3.39	0.001
Antidepressant use	2.01	1.22–3.33	0.006
Antihistamine use	1.69	1.04–2.73	0.04

DEQ5 = Dry Eye Questionnaire 5; CI = confidence interval; DE = dry eye.

^aVariables included in analysis but that did not remain significant include: age, gender, Hispanic ethnicity, use of glaucoma medications, use of anxiety medications, depression and posttraumatic stress disorder.