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Eye Symptom Questionnaire to Evaluate Anterior Eye Health

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Abstract

Objectives—Ophthalmologists assess eye complaints with a careful history and eye examination; however, other types of physicians have limited tools to evaluate anterior segment (AS) eye diseases. We identified the eye symptom questions that providers should ask to help determine the presence and urgency of AS eye diseases.

Methods—Persons with and without AS disease completed a self-report eye symptom questionnaire (ESQ) based on NIH Toolbox symptom items in an academic center's corneal and comprehensive eye clinics. Gold standard ophthalmic examination determined the presence and urgency of AS disease. The association between reported symptom severity and the probability of AS disease, or urgent AS disease, was evaluated using logistic regression models, and sensitivity and specificity of the ESQ was also calculated.

Results—A total of 324 eyes of 162 subjects were included in the study. AS disease was present in 255 eyes (79%), of which 111 eyes had urgent disease. Increasing symptom severity for eye pain (odds ratio (OR)=2.58, $p<0.001$), glare (OR=2.61, $p=0.001$), and blurry vision (OR=1.98, $p<0.001$) were associated with increased odds of AS disease. Increasing symptom severity for eye pain (OR=2.02, $p<0.001$), eye redness (OR=1.69, $p=0.02$) and blurry vision (OR=1.41, $p=0.01$) were associated with increased odds of urgent AS disease. For the primary analysis with mild symptoms considered relevant, the sensitivity of the ESQ to detect AS disease was 83% and to detect urgent AS disease was 92%.

Conclusion—Symptoms of eye pain, glare, redness, and blurry vision indicate the presence and urgency of AS disease.

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Keywords

Questionnaire; Symptoms; Eye; Anterior Segment; Cornea

Blindness or visual impairment resulting from many anterior segment (AS) diseases, such as corneal ulcers, could be prevented or treated with appropriate management.^{1, 2} Globally, corneal diseases cause bilateral blindness in 4.9 million persons and cause monocular vision loss in 23 million persons.² Eye doctors provide care for patients with or at risk for eye diseases and have prior training and experience to ask questions to triage and manage eye complaints.

But many patients do not receive eye care from an eye care provider.^{3–7} Many patients go to their primary care provider (PCP) or the emergency department (ED) providers for ophthalmic care instead of an eye care provider.⁸ Patients go to non-ophthalmic clinics for eye complaints for three main reasons. First, patients do not necessarily have preexisting relationships with eye doctors. Second, some insurances restrict access to specialists, so patients go to PCPs or ED providers to manage eye complaints. Third, some eye clinics are not open at the time that people have eye complaints (nights and weekends)..^{8–11} However, PCPs and ED providers often lack ophthalmic knowledge because of limited medical school training in eye care, resulting in a heterogeneous quality of triage and management of eye complaints.^{12, 13} Studies have shown that PCPs have low confidence when managing eye complaints.^{14, 15} Therefore, patients often receive care from providers who have few resources to determine the presence or urgency of eye disease.

Our goal was to use a self-report questionnaire to identify the key symptoms that could help non-ophthalmic providers determine the presence and urgency of AS diseases. We believe such knowledge would be useful for PCPs in assessing AS eye disease presence and urgency. While honing in on specific symptoms is routine for ophthalmologists, the eye symptoms of highest importance may be less well known to non-ophthalmic providers.

Self-report symptom questionnaires have been successfully used in non-ophthalmic fields. For example, a symptom questionnaire for chest pain had a specificity of 89% for detecting coronary heart disease and used as a screening tool to better understand the prevalence of this disease in multiple populations.^{16, 17} Validated questionnaires exist for identifying visual function, eye symptoms, or specific eye diseases across multiple domains.^{18–20} We utilized the National Institutes of Health (NIH) Toolbox Vision-related Quality of Life (VQOL) survey and focused on one domain, eye symptoms.¹⁹ In prior work, we found that a self-report Eye Symptom Questionnaire (ESQ) unveiled more patient-reported symptoms than data extracted from the medical record during the same clinical encounter.²¹ We believe that patient self-report using a questionnaire will vary less across clinical settings regardless of provider differences. Thus, we used the ESQ to determine the relevant symptoms that are significantly associated with AS disease presence and urgency.

METHODS

Participants

After approval from the University of Michigan Institutional Review Board, we recruited patients at the Kellogg Eye Center comprehensive and cornea clinics. Informed consent was obtained for all participants enrolled in the study, and the study followed the tenets of the Declaration of Helsinki. We approached consecutive patients in the clinics over a five-month time period. Patients had to be at least 18 years old to be included in the study. Exclusion criteria included patients who had incisional corneal surgeries or patients who were in the 90-day postoperative period from eye surgery. We excluded patients with prior corneal surgery as these patients could manifest different symptomatology.

Questionnaire Design

We designed the ESQ using question phrasing from pre-validated measures rather than create a new questionnaire for this population with more than one disease. We used the NIH Toolbox VQOL survey (seven symptom questions), one symptom item (eye pain) from the National Eye Institute-Visual Function Questionnaire (NEI-VFQ), and one symptom item (gritty sensation) from the Ocular Surface Disease Index (OSDI) (Supplemental Digital Content 1 - Eye Symptom Questionnaire).^{18–20} The NIH Toolbox VQOL survey focused on vision-related health to measure patient-centered vision health outcomes.¹⁹ The NEI-VFQ measured visual-related quality of life with an emphasis on functioning, and has been validated across several disease categories.¹⁸ The OSDI was created to assess dry eye syndrome.²⁰ Because eye disease and disease severity is not always bilateral and symptoms can differ between eyes, we collected symptom report for each eye separately for each eye symptom question on the ESQ (e.g. symptoms in the right eye and in the left eye). Responses indicated severity of symptoms on an ordinal scale (none/mild/moderate/severe/very severe or no problem at all/a little bit of a problem/somewhat of a problem/very much of a problem).

The face validity of the ESQ was assessed by expert review (eight corneal specialists and two corneal fellows) and by interviewing the first 40 consented patients to provide feedback. These subjects were excluded from the analysis. Based on this feedback, we revised the ESQ formatting but not the question content nor phrasing. The final instrument consisted of eight eye symptom questions and one general symptom question regarding headaches. The final measure had a readability score of 6.4 (6th–7th grade) as assessed by the Flesch-Kincaid software in Microsoft Office.

Masked Assessment of Clinical Diagnoses

A cornea specialist, who was masked to the results of the questionnaire, reviewed the medical record to determine if the patient had any AS diagnoses, in either eye, at the time of the clinical encounter. The diagnoses were grouped into 14 categories of disease, each indicated as urgent or non-urgent. (Supplemental Digital Content 2-Categorized Anterior Segment Diseases). Of note, one category of disease (conjunctivitis) has sub-categories that are both non-urgent (allergic) and urgent (viral). The diseases included six categories classified as non-urgent: cataract, allergic conjunctivitis, contact lens related problems,

corneal scars/opacities, dry eye syndrome, and refractive error. Nine disease categories were classified as urgent: viral conjunctivitis, corneal abrasions, corneal degenerations, corneal dystrophies, infectious keratitis, inflammation, ocular surface malignancy, other corneal diseases (e.g. Stevens-Johnson syndrome, Ocular Cicatricial Pemphigoid), and trauma. Disease categories followed traditional corneal categories.^{2, 22–33} We also reviewed the participant's medical record to identify other reported eye symptoms that were not included in the questionnaire (Supplemental Digital Content 3-Other Symptoms).

Statistical Analysis

Descriptive statistics of the sample were summarized with means and standard deviations (SD) for continuous measures and frequencies and percentages for categorical variables, for both subject-based and eye-based characteristics. Presence of eye symptoms was defined as a response of moderate/severe/very severe (one question) or a response of somewhat of a problem/very much of a problem (seven questions).

Univariable and multivariable logistic regression models were investigated to assess the association between severity of the eye symptom report and the probability of AS disease. Because symptoms were recorded per eye and subjects contributed both eyes to the study, generalized estimating equation (GEE) methods were used to obtain robust standard error estimates in the presence of correlated data.³⁴ Model selection used the method of best subsets with the score statistic as the selection criteria. We evaluated for multicollinearity and all final effects in the multivariable model showed an independent association with the outcome. As a secondary outcome, we investigated the relationship between severity of symptom report and eyes having urgent AS diseases (e.g. infectious) or not (non-urgent AS diseases or eyes without any AS disease) (Supplemental Digital Content 2-Categorized Anterior Segment Diseases). Logistic regression with GEE was used to assess this relationship.

Sensitivity and specificity of the ESQ to detect AS disease, or urgent AS disease, compared to the diagnosis by gold standard ophthalmic examination were calculated. Results from our logistic regression models were used to identify symptoms from the ESQ independently associated with increased odds of presence of AS disease and urgency of AS disease. Multiple cut-points of symptom severity were used to show the impact on sensitivity and specificity statistics (symptom presence as a severity report of "mild" or "a little bit of a problem" or worse; symptom presence as a severity report of "moderate" or "somewhat of a problem" or worse). 95% Wilson confidence intervals (CI) were also provided. All analyses used SAS v9.4 software (SAS institute, Cary, NC).

RESULTS

For study enrollment, 243 subjects were approached. The initial 40 subjects' data were excluded because they were enrolled to test face validity of the ESQ, an additional 40 subjects met exclusion criteria, and one subject was excluded because of an incomplete clinical examination. A total of 162 subjects (324 eyes) were included in the analysis. Table 1 shows subject- and eye-based characteristics of the sample. Mean ($\pm$ SD) subject age was 56.6 ± 19.4 years (range, 18.4 to 94.0). Sixty-two percent of subjects were female. Mean

logMAR visual acuity was 0.34 ± 0.64 (range, -0.12 to $+3.00$). (Vision of 0.34 logarithm of the minimal angle of resolution (logMAR) equates to a Snellen visual acuity of $\cong 20/40$ – $20/50$). AS disease was present in 79% of eyes (255 eyes of 156 subjects) and absent in 21% of eyes (69 eyes of 63 subjects). Six subjects had no evidence of AS disease in either eye, 57 subjects had one eye with documented AS disease and one eye with no documentation of AS disease, and 99 subjects had bilateral AS disease. Urgent AS disease was present in 34.3% of all eyes (111 eyes of 88 subjects) and absent in 65.7% of eyes (213 eyes of 139 subjects). Twenty-three subjects (26%) had both eyes classified as having urgent AS disease.

Eye Symptoms

The percentage of eyes with reported ocular symptoms (e.g. eye pain, glare, etc.) differed depending on whether AS disease was present or absent (Figures 1A). The number of reported symptoms varied by presence of AS disease and urgent status (Figure 1B). The mean number of eye symptoms was 0.4 ± 1.1 (median=0) for eyes without AS disease compared to 2.3 ± 2.4 (median=2) for eyes with AS disease.

We also examined inconsistencies in ESQ symptom reporting and presence of disease. In eyes with no AS disease, 18.8% (n=13 of 69 eyes) had ocular symptoms reported on the ESQ and fell into two categories: symptoms related to posterior segment disease (10 eyes) and inconsistent reporting between the ESQ and the medical record (3 eyes).

In eyes with AS disease, 31.4% (n=80 of 255 eyes) had no report of ocular symptoms on the ESQ. These asymptomatic eyes with AS disease fell into three categories: those with very mild, inactive, or resolved AS disease (41 eyes), those with inconsistent reporting between the ESQ and medical record (33 eyes), and those with other symptoms that were not on the ESQ (6 eyes).

Questionnaire on Probability of AS Diseases

In univariable analysis, increasing severity of symptoms was significantly associated with increased odds of having AS disease, for all symptoms (all p values < 0.003 , Table 2), except for the subject-based symptom regarding headache (p = 0.07). In the multivariable model, reporting worse symptom severity for eye pain (adjusted OR=2.58, 95% CI=1.51–4.40, p<0.001), glare (adjusted OR=2.61, 95% CI=1.46–4.67, p=0.001), and blurry vision (adjusted OR=1.98, 95% CI=1.37–2.87, p<0.001) were independently associated with increased odds of AS disease (Table 2).

Questionnaire on Probability of Urgent AS Diseases

In univariable analysis, reporting worse severity of all symptoms was significantly associated with increased odds of having urgent AS disease (all p values < 0.005 , Table 3), except for the subject-based symptom regarding headache (p=0.77). In the multivariable model, reporting worse symptom severity for eye pain (adjusted OR=2.02, 95% CI=1.34–3.05, p<0.001), eye redness (adjusted OR=1.69, 95% CI=1.08–2.63, p=0.02), and blurry vision (adjusted OR=1.41, 95% CI=1.07–1.85, p=0.01) were associated with increased odds of urgent AS disease (Table 3).

Sensitivity of the ESQ to detect AS Disease

Using the eye symptoms on the ESQ that were significantly and independently associated with increased odds of presence of AS disease or presence of urgent AS disease (Table 2 and 3: eye pain, glare, blurry vision, or eye redness), we defined the presence of disease as at least one of these symptoms reported at a severity of “mild” or “a little bit of a problem” or worse. With this definition, the sensitivity of the ESQ to detect AS disease compared to the clinical diagnosis was 82.8% (CI, 77.6–86.9) and the specificity was 60.9% (CI, 49.1–71.5) (Table 4). Similarly, the sensitivity of the ESQ to detect urgent AS disease was 91.9% (CI, 85.3–95.7) and the specificity was 36.2% (CI, 30.0–42.8). If we required a more severe symptom level for disease presence at a severity of “moderate” or “somewhat of a problem” or worse, sensitivity decreases and specificity increases (Table 4).

DISCUSSION

Methods to monitor and evaluate for eye diseases remotely exist for diabetic retinopathy and retinopathy of prematurity, but do not exist for AS diseases.^{35, 36} Imaging with photographs and questionnaires for symptom reporting are two potential methods to remotely evaluate AS diseases. Taking pictures of AS pathologic conditions is complex and can be costly, but some promising work exists to validate low-cost technology.³⁷ An alternative and complementary approach is to focus on symptoms of AS diseases. In our study, each higher level of reported symptom severity for eye pain, glare, or blurry vision was associated with a 98–161% increase in the odds of having an AS disease. Each higher level of reported symptom severity for eye pain, eye redness, and blurry vision was associated with a 41–102% increase in the odds of having an urgent AS disease. Our results are consistent with previous reports in the literature. In one large study of 2,324 eyes, patients with contact lens related corneal infiltrates (n=38, 1.6%) reported redness (89.7% of patients), pain (72.4%), photophobia (72.4%), and foreign body sensation (69.0%) using a Likert scale for symptom reporting. The researchers did not compare symptoms of cases versus controls to see which, if any, symptoms were significantly associated with disease.³⁸ Another small study of six eyes of patients with corneal infiltrates described that patients reported pain, photophobia, and injection.³⁹

Our results indicate that PCPs and ED providers can ask about four key eye symptoms: eye pain, glare, blurry vision, and eye redness. These symptoms were independently associated with increased odds of presence or urgency of AS disease. Answering any one of these four questions with a positive response for symptom presence yielded 82.8% sensitivity to detect AS disease, and 91.9% sensitivity to detect urgent AS disease. Chan et al. found that 80% of family medicine doctors were somewhat or not at all comfortable managing eye diseases.¹⁵ If providers ask targeted eye symptom questions, they could enhance patient safety and likely improve the quality of their patients’ eye care.

Symptom reporting is important for other reasons as well. Eye and visual symptoms impact overall health.⁷ In a large cohort of young patients, monthly symptoms of blurred vision had a higher impact on functioning and on quality of life than type II diabetes mellitus, indigestion, trouble urinating, and headaches.⁴⁰ By asking questions about eye and vision

symptoms to our patients, as eye care or non-eye care providers, we can more richly appreciate the impact that eyes and vision have on a patient's well-being.

We evaluated how presence of certain eye symptoms is related to the clinician's categorization of AS disease; however, this method is not without flaws. Positive symptom reporting was present in 18.8% of eyes with no evident AS disease upon examination. Conversely, no eye symptoms were reported in 31.4% of eyes with AS disease. We had to choose a certain threshold in responses on the questionnaire to declare a symptom as "positively reported". If we changed that threshold to categorize the lowest level of a symptom as positively reported, we would increase the percentage of eyes with reported symptoms but no AS disease (false positive rate) and would decrease the percentage of eyes with AS disease and no symptoms (false negative rate).

Other limitations to this study exist. The questionnaire was limited in scope and does not address all possible eye and visual symptoms. By combining questions from pre-existing measures included in the NIH Toolbox, we did not create and validate a symptom questionnaire specific to our population of patients with AS diseases. We focused on the presence or absence of AS disease, but other diseases can also have AS symptoms (for example, side effects from medication drop toxicity). This study was conducted in an academic center's eye clinic setting, and not in primary care clinics or the ED. We believe our calculated sensitivity and specificity will change in the primary care setting. We had a corneal specialist code all disease diagnoses based on the medical record. In doing so, resolved disease or non-visually significant disease (such as mild dry eye syndrome) would still be coded as positive disease, and thus lead to inconsistencies between symptom report on the ESQ and clinical diagnosis. The next goal is to testing the ESQ in primary care settings and to tighten the classification of clinically significant AS disease.

Symptoms of eye pain, eye redness, glare, and blurry vision are the key questions that indicate AS disease presence and disease urgency. These four questions will be the basis for a future questionnaire to be validated in primary care and emergency department settings. If these symptoms prove to have high sensitivity for detecting AS disease in those settings, a provider, paraprofessional, or patient could use a self-reported questionnaire to detect AS disease and its urgency.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

A: Bar chart displaying the percent of eyes reporting symptoms stratified by eyes with or without anterior segment (AS) diseases, and 1B: Bar chart displaying the percent of eyes by number of reported ocular symptoms, stratified by eyes without AS disease (normal) or with AS disease (non-urgent or urgent). Symptoms were categorized as present if the patient reported moderate/severe/very severe for eye pain or reported somewhat of a problem/very much a problem for other eye symptoms and headache.

Table 1

Descriptive statistics

Subject-based characteristics (n=162)	
	Frequency (%)
Female	101 (62.3)
Race	
White	135 (84.9)
Black	11 (6.9)
Asian	11 (6.9)
Other	2 (1.3)
Contact Lenses (yes)	31 (19.3)
Age (years)	
Mean (SD)	56.6 (19.4)
Median	60.7
Range	18.4–94.0

Eye-based characteristics (n=324)	
LogMAR VA *	
Mean	0.34 (0.64)
Median	0.18
Other	−0.12 – 3.00
AS Disease Presence	Frequency (%)
Yes	255 (78.7)
No or Normal	69 (21.3)
AS Disease Class (n=255)	
Urgent	111 (34.3)
Non-Urgent	144 (56.5)
Primary AS Diagnosis (n=255)	
Dry Eye Syndrome	101 (39.6)
Infectious	51 (20.0)
Inflammation	9 (3.5)
Trauma	11 (4.3)
Contact Lens Related	3 (1.2)
Vision, Not Symptom	34 (13.3)
Other	46 (18.0)

SD, standard deviation; AS, anterior segment; VA, visual acuity

*
n=320;

4 eyes with “light perception” VA were not included in logMAR VA statistics

Table 2

Logistic regression models predicting the probability of having AS disease (n=255) versus no AS disease (n=69)

Symptom	Univariable		Multivariable	
	OR* (95% CI)	p value	OR (95% CI)	p value
Pain / Discomfort ^a	3.30 (1.88, 5.81)	<0.001	2.58 (1.51, 4.40)	<0.001
Burning / Stinging ^b	2.76 (1.42, 5.38)	0.003	-	-
Itching ^b	2.60 (1.65, 4.08)	<0.001	-	-
Gritty Sensation ^b	9.11 (2.82, 29.43)	<0.001	-	-
Redness ^b	3.99 (1.75, 9.12)	0.001	-	-
Glare ^b	9.32 (3.58, 24.23)	<0.001	2.61 (1.46, 4.67)	0.001
Sensitive to Light ^b	5.74 (2.66, 12.36)	<0.001	-	-
Blurry Vision ^b	3.71 (2.02, 6.83)	<0.001	1.98 (1.37, 2.87)	<0.001
Headaches ^b	0.79 (0.61, 1.02)	0.07	-	-

AS, Anterior Segment; OR, Odds ratio; CI, Confidence interval

* OR presented for a 1 level increase in symptom severity

^aSymptom severity response: none/mild/moderate/severe/very severe

^bSymptom severity response: no problem at all/a little bit of a problem/somewhat of a problem/very much of a problem

“ - ” symptom not included in best subset multivariable model

Table 3

Logistic regression models predicting the probability of having urgent AS disease (n=111) versus non-urgent or no AS disease (n=213; non-urgent AS disease (n=144) and eyes without any AS disease (n=69))

Symptom	Univariable		Multivariable	
	OR* (95% CI)	p value	OR (95% CI)	p value
Pain / Discomfort ^a	3.32 (2.39, 4.61)	<0.001	2.02 (1.34, 3.05)	<0.001
Burning / Stinging ^b	2.76 (1.99, 3.82)	<0.001	-	-
Itching ^b	1.58 (1.15, 2.18)	0.005	-	-
Gritty Sensation ^b	2.41 (1.71, 3.41)	<0.001	-	-
Redness ^b	3.30 (2.40, 4.55)	<0.001	1.69 (1.08, 2.63)	0.02
Glare ^b	2.28 (1.75, 2.96)	<0.001	-	-
Sensitive to Light ^b	2.08 (1.60, 2.70)	<0.001	-	-
Blurry Vision ^b	1.99 (1.58, 2.50)	<0.001	1.41 (1.07, 1.85)	0.01
Headaches ^b	1.03 (0.83, 1.29)	0.77	-	-

AS, anterior segment; OR, Odds ratio; CI, Confidence interval

* OR presented for a 1 level increase in symptom severity

^aSymptom severity response: none/mild/moderate/severe/very severe

^bSymptom severity response: no problem at all/a little bit of a problem/somewhat of a problem/very much of a problem

“ - ” symptom not included in best subset multivariable model

Table 4

Sensitivity and specificity of the ESQ to detect AS disease, or urgent AS disease, compared to diagnosis documented in the medical record

AS Disease by ESQ	Presence of AS Disease			
	Disease (n=255 Eyes)	No Disease (n=69 Eyes)	Sensitivity (95% CI)	Specificity (95% CI)
Definition 1				
Key symptoms ^a reported mild [*]	211	27		
Key symptoms ^a reported = none ^{**}	44	42	82.8 (77.6, 86.9)	60.9 (49.1, 71.5)
Definition 2				
Key symptoms ^a reported moderate ^{***}	163	8		
Key symptoms ^a reported mild [*]	92	61	63.9 (57.9, 69.6)	88.4 (78.8, 94.0)
Urgency of AS Disease				
Urgent Disease (n=111 Eyes) No Disease/ Non-Urgent Disease (n=213 Eyes)				
Definition 1				
Key symptoms ^a reported mild [*]	102	136		
Key symptoms ^a reported = none ^{**}	9	77	91.9 (85.3, 95.7)	36.2 (30.0, 42.8)
Definition 2				
Key symptoms ^a reported moderate ^{***}	86	85		
Key symptoms ^a reported mild [*]	25	128	77.5 (68.9, 84.3)	60.1 (53.4, 66.4)

AS = Anterior Segment, ESQ = Eye Symptom Questionnaire, CI = Confidence Interval

Note: responses to symptom severity on the ESQ for eye pain were none/mild/moderate/severe/very severe; responses to symptom severity on the ESQ for symptoms of glare, blurry vision, and eye redness were no problem at all/a little bit of a problem/somewhat of a problem/very much of a problem

^aKey symptoms = eye pain, glare, blurry vision, eye redness

^{*} or 'little bit of a problem';

^{**} or 'no problem at all';

^{***} or 'somewhat of a problem'