The effect of a Computer Lens Filter on visual performance in subjects with retinitis pigmentosa

Zhangmei Guo
Wenzhou Medical University
Lingzhi Ni
Wenzhou Medical University Eye Hospital
Na Lin
Wenzhou Medical University Eye Hospital
Yu Zhu
Wenzhou Medical University
Longfei Jiang
Wenzhou Medical University Eye Hospital
RUzhi Deng (drz@mail.eye.ac.cn)
Wenzhou Medical University Eye Hospital https://orcid.org/0000-0002-4587-7223

Research article

Keywords: Contrast sensitivity; Computer lens filters; Retinitis Pigmentosa; Visual quality; Screen reading; The LED light

Posted Date: February 21st, 2019

DOI: https://doi.org/10.21203/rs.2.369/v1

Abstract

Background：Retinitis pigmentosa (RP) patients uauslly complained nyctalopia and poor dark adaptation which caused their visual discomfort, in this study we aimed to explore the effects of a Computer Lens Filter (CLF) on contrast sensitivity (CS), reading speed for computer screen text and visual comfort in subjects with retinitis pigmentosa (RP), and to find wheather CLF would be helpful for RP patients . Method: Twenty-two subjects diagnosed with binocular RP participated. Bright CS using the Mars test and reading speed of screen text were measured using the spectacle corrections for best corrected visual acuity (BCVA) both with and without CLF wear. Subjective estimates of computer screen brightness and visual comfort were evaluated by questionnaire. These functions were compared for the two conditions of filter wear/non-wear. Result： Mean subject age was 38.2±7.5 years and mean log MAR VA was .45± .24. Wearing a CLF neither improved bright CS ($t = .452$, $P=.653$) nor increased reading speed ($t =.414$, $P = .683$). CLF wear was judged to reduce screen brightness ($t = 5.412$, $P<.0001$) and improve visual comfort ($t = 6.897$, $P<.0001$). Conclusion： CLF wear neither improved RP subjects’ CS nor reading speed for screen text but did reduce the appearance of screen brightness and improve subjects’ reported visual comfort. Improvement in comfort alone may be sufficient justification for filter use as a vision aid for RP patients during vision rehabilitation.

Background

Retinitis pigmentosa (RP) is a bilateral retinal hereditary dystrophy. The most common symptoms for this disease are nyctalopia and poor dark adaptation, reduced central VA and blue-yellow channel dyschromatopsia [1]. The incidence of RP is about 1/4000 with an estimated millions of RP patients worldwide [2]. Vision impairment in RP is progressive with early symptoms including night blindness and constriction of visual fields. RP causes more difficult pedestrian orientation and mobility, and together with reduced VA it impairs recognition of detail and slows the reading rate [3]. Reading is the second most important near vision demand reported by low vision patients in China [4]. Our reliance on computers to execute work-related tasks has increased [5] resulting in more commonly reported visual fatigue[6] from increased blue light emissions of LED-backlit liquid crystal displays[7]compared with previous-generation cathode ray tubes. Selected wavelength filters protect the retina and other ocular tissues against sunlight glare and contribute to ocular comfort in RP low vision [8, 9]. Filters improve the quality of vision by reducing recovery durations for light adaptation. They increase retinal image contrast and decrease light dispersion and chromatic aberration inside the ocular media, improving visual comfort [10].

Previous studies have shown that wearing a blue UV filter during computer use reduces glare and visual fatigue [7, 11, 12]. However, these studies do not indicate whether an associated improvement in visual comfort of RP patients occurs with filter wear.

We analyzed bright CS, reading speed and visual comfort of our RP subjects when reading text on a computer with and without CLF wear. We sought also to determine whether wearing a CLF improved visual comfort and warranted prescription as an effective low vision aid during vision rehabilitation.

Methods

Subjects

We recruited 22 patients who attended the Low Vision Rehabilitation Center in the Eye Hospital of Wenzhou Medical University from October to December in 2017 to participate. All had been diagnosed with binocular retinitis pigmentosa. The study was conducted in compliance with good clinical practice guidelines, institutional review board regulations and the tenets of the Declaration of Helsinki. All subjects were given a written explanation of the study and consented in writing to participate. Our consent form explained that enrolment in this study did not imply any risk to ocular health and provided the right of withdrawal from the study at any time.

Inclusion criteria were: 1) both eyes were diagnosed with retinitis pigmentosa, and 2) VA with best spectacle correction was better than 20/400.

Exclusion criteria were: 1) the presence of other diseases that affected VA, such as corneal ulcer, pterygium and cataract; 2) a history of eye surgery, such as laser surgery and cataract surgery; 3) other ocular fundus diseases, such as diabetic retinopathy, glaucoma, optic nerve disease, etc; 4) congenital color blindness, mental handicap, illiteracy, and 5) refusal to answer the questionnaire.

Material and methods

1. **Computer Lens Filter**

We used a commercially available CLF from Fitovers (Jonathan Paul Eyewear Pty Limited) as blue-light blocking spectacle lenses. Information provided by the manufacturer are transmission spectrum (Figure 1) and specific filter parameters (Table 1).

2. **The computer display**

Our computer was a *Lenovo Small New 700*, with a 15.6 inch screen, a display resolution of and maximum screen illumination of 200 cd/m^2. Text was presented at the maximum illumination level.

3. **The reading content**

We selected reading content from the Chinese Reading Visual Acuity Chart written by Wang Chenxiao, This chart contains three similar sentences, each with 30 characters, as shown in figure 2. Each subject chose a font size consistent with their VA demand for clear and comfortable reading at their habitual screen distance.

4. **The bright contrast sensitivity**

CS at near was measured monocularly on the basis of corrected VA using the Mars Numeral Contrast Sensitivity test, measured first without CLF, then with the filter. Illuminance of the examination room was

85 cd/m^2 and the test distance was 0.5 m. Examination commenced with the MARS first visual target and subjects were asked to identify targets one by one until two continuous errors occurred, at which stage the test was stopped and the result recorded.

5. **Reading speed test on computer**

RP subjects sat in front of the computer at their habitual reading distance. Using page E as the reading example, subjects adjusted font size until they could read clearly and comfortably. Reading test speeds were recorded by presenting Pages A and B both with and without the CLF but in random sequence. Words that subjects did not know or could not identify were skipped. Subjects were given a 5 minutes break between each test.

6. **Questionnaire**

Any subjective perception of change in visual comfort and brightness of the computer before and after wearing the CLF were recorded using a questionnaire. At the end of each reading test we asked subjects to grade comfort level and perception of screen brightness on linear scales from +10 to -10. 'Zero' was defined as the base line score for comfort level without the CLF. The higher the score, the more comfortable the task and brighter the screen text. Questionnaire scales are shown in figure 3.

Data analysis

Results were tabulated and comparisons tested using SPSS V23.0. Statistical significance was judged to be $P<0.05$.

Results

Patient characteristics

The average age of subjects was 38.2±7.5 years and the ratio of males to females was 6:16. Average logMAR visual acuity was 0.45 ± 0.24.

Questionnaire

Wearing CLF both improved RP subjects' visual comfort and reduced computer screen brightness compared with the no-filter condition. Subjects rated visual comfort using the CLF as 4.045 ($P< .0001$), an improvement over the no-filter condition. At the same time, subjects reported that CLF wear reduced screen brightness compared with the no-filter condition (-2.820, $P< .0001$). See table 2, figure 4.

The bright contrast sensitivity

Mean bright CS with CLF wear was .978 and .970 with no filter ($P > .05$, ns). CLF wear did not increase bright CS in our subjects. See table 2.

The reading speed

CLF wear did not increase subjects' reading speeds. The average reading speed with CLF was 209.1 and without filter 210.2 (characters /min) ($P > .05$, ns). See table2.

Discussion

Photophobia and light-induced interference with visual comfort and performance are the main complaints of RP patients [13, 14]. Discomfort is usually reported as glare, reflections, flicker and non-uniformity of illumination, all interfering with task performance [15]. Probable causes of these symptoms in RP patients are: (1) general photophobia caused by light scatter, since the retinal pigment epithelium can no longer absorb light normally. This causes poor adaptation to different illumination levels because of the lack of photoreceptor function [16, 17]. (2) increased levels of intraocular light scatter that decrease retinal image quality cause glare and photophobia [18, 19].

Gonzalo Carracedo et al. showed that only 11% of RP patients wearing a CPF-527 filter reported improvement in visual comfort for indoor activities of daily living [20]. In our study, for 95% of subjects (21/22) CLF wear improved comfort during computer use. Possible reasons for the difference between the two studies were the filter type and the visual task. Our CLF filtered 100% of wavelengths <400 nm and 71% of wavelengths between 400-500 nm, with a total luminance transmittance of 74.5%. The CPF-527 filter Carracedo et al. used removed only 90% of the wavelength <550 nm with a luminance transmittance of 21%. Total transmittance may be one contributing factor to visual comfort and an explanation of difference. Second, we investigated visual comfort when RP patients read text on a computer screen. Carracedo et al. studied the visual comfort during a broader range of their subjects' general daily activities. These are important differences between visual task conditions.

Declines in CS with progression of RP lead to difficulty in daily tasks [21, 22]. Van den Berg, Gonzalo Carracedo et al. found that RP patients wearing filters had improved CS [20, 23]. While Juan et al. showed that filters improved visual discrimination for their RP patients [15]. In our study, CLF wear did not enhance CS, a finding similar to that of L. Colombo's et al [24]. differences in spectral and luminance transmission of the various filters used may be a reason for these disparities in CS. Van den Berg, and Gonzalo Carracedo, both used CPF-527 filters that filter out 98% the wavelength below 527nm with a 32% transmittance.

Gianni Virgili et al. pointed out that reading difficulty for RP patients is closely related to progressive reduction of visual field, gradual loss of vision and significant reduction of high frequency CS [3]. Janet P. found statistically significant correlations between the clinical measures of vision such as CS and the functional performance of daily tasks, where better CS was associated with better reading performance [22]. We used random text sequences to eliminate any learning effect for accuracy of reading speed. The fact that CLF wear neither enhanced CS nor expanded the visual field of RP subjects [24] is our explanation for no change in reading speed with filter wear.

Although CS and reading speed did not improve with filter wear, our subjects reported that their visual comfort improved. This finding suggests that patients with RP who experience photophobia when reading on a computer screen can be prescribed a CLF to improve their comfort and quality of life.

Conclusion CLF wear neither improved RP subjects' CS nor reading speed for screen text but did reduce the appearance of screen brightness and improve subjects' reported visual comfort. Improvement in comfort alone may be sufficient justification for filter use as a vision aid for RP patients during vision rehabilitation.

Abbreviations

RP: Retinitis pigmentosa **CLF:** Computer Lens Filter

BCVA: best corrected visual acuity **CS:** contrast sensitivity

MAR: Minimum Angle of Resolution **LED:** Light Emitting Diode

Declarations

Ethics approval and consent to participate

This study was approved by the Human Research Ethics Committee of the Wenzhou medical university Eye Hospital [No. KYK[2018]02] and complied with the Declaration of Helsinki. Written informed consents were obtained from the patients.

Consent for publication

All authors approved the manuscript for publication, but there is not applicable of consent for the publication of identifying images or other personal or clinical details of participants that compromise anonymity.

Availability of data and materials

The datasets used during the current study available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

This work was supported by Clinical study on mental health status of patients with low vision caused by high myopia, no. Y20160561 .This fundinghad no role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Authors' contributions

Conceptualization: ZMG,LZN ; Data Curation: ZMG; Writing – Original Draft: ZMG, LZN; Formal Analysis: ZMG; Project Administration: LZN, NL , YZ , LFJ; Supervision: Lingzhi Ni; Writing –Review & Editing: ZMG , LZN. All authors have read and approved the manuscript for submission.

Acknowledgments: The authors would like to thank all the study participants for making this study possible. We acknowledge Dr. Alan Johnston for his constructive comments and English editing.

References

1. Shintani K, Shechtman DL, Gurwood AS (2009) Review and update: current treatment trends for patients with retinitis pigmentosa. Optometry 80:384–401. https://doi.org/10.1016/j.optm.2008.01.026
2. Daiger SP , Sullivan LS , Bowne SJ. (2013) Genes and mutations causing retinitis pigmentosa. Clin Genet, 84(2):132-141. http://doi.org/10.1111/cge.12203
3. Virgili G , Pierrottet C , Parmeggiani F , et al (2004) Reading Performance in Patients with Retinitis Pigmentosa: A Study Using the MNREAD Charts. Invest Ophth Vis Sci, 45(10):3418. http://doi.org/10.1167/iovs.04-0390
4. Lin N, Wang X, Jiang L, et al. (2016) The baseline traits and visual rehabilitation of patients at a low vision clinic. Chinese Journal of Optometry Ophthalmology and Visual Science, 18:488-492. http://doi.org/10.3760/cma.j.issn.1674-845X.2016.08.009
5. Wang AH , Tseng CC, Jeng SC. (2007) Effects of bending curvature and text/background color-combinations of e-paper on subjects' visual performance and subjective preferences under various ambient illuminance conditions. Displays, 28(4-5):161-166. https://doi.org/10.1016/j.displa.2007.06.003
6. Takeshi, Toda, Ikuko, et al. (2015) Effect of Blue Light–Reducing Eye Glasses on Critical Flicker Frequency. The Asia-Pacific Journal of Ophthalmology, 4(2):80-85. http://doi.org/10.1097/APO.0000000000000069
7. Siegenthaler, Y. Bochud, P. Bergamin, P. Wurtz. (2012) Reading on LCD vs e-Ink displays: effects on fatigue and visual strain. Ophthal Physl Opt, 32:367-374. http://doi.org/10.1111/j.1475-1313.2012.00928.x
8. Rosenblum, PP, Zak, MA, Ostrovsky, et al. (2000) Spectral filters in low-vision correction. Ophthal Physl Opt, 20(4):335-41. http://doi.org/10.1046/j.1475-1313.2000.00545.x

9. Frank E, Fowler CW, Evans BJ. (2002) Do tinted lenses or filters improve visual performance in low vision? A review of the literature. Ophthal Physl Opt, 22(1):68-77. http://doi.org/10.1046/j.1475-1313.2002.00004.x
10. Leat SJ, North RV, Bryson H. (2010) Do long wavelength pass filters improve low vision performance?. Ophthalmic & Physiological Optics, 10(3):219-224. http://doi.org/10.1111/j.1475-1313.1990.tb00855.x
11. Lin JB, Gerratt BW, Bassi CJ, et al. (2017) Short-Wavelength Light-Blocking Eyeglasses Attenuate Symptoms of Eye Fatigue. Invest Ophth Vis Sci, 58(1):442. http://doi.org/10.1167/iovs.16-20663
12. Kaido M, Toda I, Oobayashi T, et al. (2016) Reducing Short-Wavelength Blue Light in Dry Eye Patients with Unstable Tear Film Improves Performance on Tests of Visual Acuity. Plos One, 11(4):e0152936. http://doi.org/10.1371/journal.pone.0152936
13. Gawande AA, Donovan WJ, Ginsburg AP, et al. (1989) Photoaversion in retinitis pigmentosa. Brit J Ophthalmol, 73(2):115-20. http://doi.org/10.1136/bjo.73.2.115
14. Cedrún-Sánchez JE, Chamorro E, Bonnin-Arias C, Aguirre-Vilacoro V, Castro JJ, Sánchez-Ramos C. (2016) Visual Discrimination Increase by Yellow Filters in Retinitis Pigmentosa. Optom Vis Sci, 93(12):1537-1544. http://doi.org/10.1097/OPX.0000000000000924
15. Ahmet Çakir. (2014). Human factors in lighting. Behaviour & Information Technology, 33(10), 3.
16. de Castro C T , Berezovsky A , de Castro D D , et al. (2006) [Visual rehabilitation in patients with retinitis pigmentosa]. Arq. Bras. Oftalmol., 69(5):687. http://doi.org/10.1590/S0004-27492006000500013
17. Freid, AN. (2010). Rehabilitation: an essential component of low vision care. Clinical & Experimental Optometry, 64(3), 90-94. http://doi.org/10.1111/j.1444-0938.1981.tb02977.x
18. Shahidi MM, Yang YY , Rajagopalan ASA, et al. (2005). A method for differentiating ocular higher-order aberrations from light scatter applied to retinitis pigmentosa. Optom Vis Sci, 82(11), 976-80. http://doi.org/10.1097/01.opx.0000187842.27258.c9
19. Alexander KR, Fishman GA, Derlacki DJ. (1996). Intraocular light scatter in patients with retinitis pigmentosa. Vision Res; 36:3703-9. http://doi.org/10.1016/0042-6989(96)00068-5
20. Carracedo G, Jesús Carballo, Loma E, et al. (2011) Contrast sensitivity evaluation with filter contact lenses in patients with retinitis pigmentosa: a pilot study. J Optom, 4(4):134-139. http://doi.org/10.1016/s1888-4296(11)70055-3
21. Szlyk JP, Seiple W, Fishman GA, et al. (2001) Perceived and actual performance of daily tasks: relationship to visual function tests in individuals with retinitis pigmentosa11 The authors have no proprietary interest in this study. Ophthalmology, 108(1):65-75. http://doi.org/10.1016/S0161-6420(00)00413-9
22. Sumi I, Matsumoto S, Okajima O, et al. (2000) The Relationship Between Visual Disability and Visual Scores in Patients With Retinitis Pigmentosa. Jpn J Ophthalmol, 44(1):82-87. http://doi.org/10.1016/S0021-5155(99)00171-9

23. Berg TJ. (1989) Red glasses and visual function in retinitis pigmentosa. Doc Ophthalmol, 73(3):255-274. http://doi.org/10.1007/BF00155095
24. Colombo L, Melardi E, Ferri P, et al. (2017) Visual function improvement using photocromic and selective blue-violet light filtering spectacle lenses in patients affected by retinal diseases. BMC Ophthalmology, 17(1):149. http://doi.org/10.1186/s12886-017-0545-9

Tables

Table 1 The specific filter parameters of CLF(Computer Lens Filter)

Glass filter	Main wavelengths filtered	Light transmission	Ultraviolet filtration rate	Blue light filtration rate
CLF	400-500nm	74.5%	100%	71%

Table 2. The results of CS, reading speed, comfort level and brightness

	Before	After	*t*	*P*
Average of CS(contrast sensitivity)	1.022.495	1.005.491	.680	.504
Average reading speed*	209.195.111	210.292.822	.223	.826
comfort level	0	4.0452.751	6.897	< .0001
brightness level	0	-2.8202.442	-5.412	< .0001

Note: * indicates that Number of characters /min

Figures

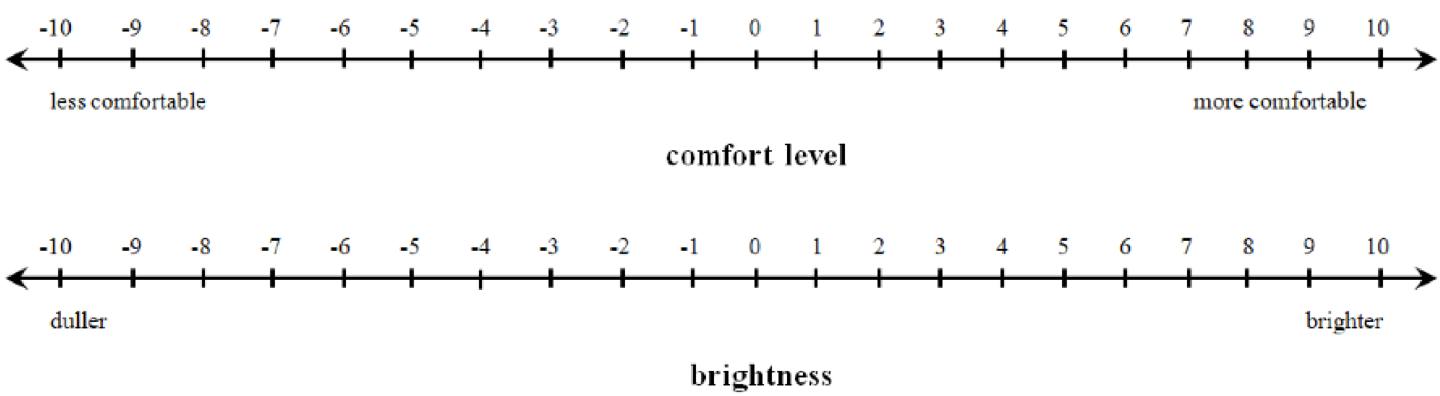

Figure 1

The questionnaire of comfort level and brightness.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- supplement1.docx