Does Blue Light Filter Improve Computer Vision Syndrome in Patients with Dry Eye?

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Abstract: Purpose: One of the principal contributing factors to computer vision syndrome (CVS) maybe the intense light, including the blue light, emanating from computer displays. The purpose of this study is to investigate if wearing blue light filters improve tear production and relieves CVS-related symptoms. **Methods:** Twenty dry eye patients, diagnosed with a baseline Schirmer's test of <10mm (mean=5.35mm), and 20 more patients with normal Schirmer's test values (mean=13.15 mm) participated in the study. The subjects were free from accommodation lag, with no other eye diseases and a habitual near Snellen visual acuity of no worse than 0.8. Blue light filters of low, medium, and high densities, were sequentially worn, each for one week. At the end of each week, and after two hours of continuous computer work on the last day, Schirmer's test was performed and a questionnaire of graded ocular complaints was also completed. Data were then analyzed with ANOVA and Post Hoc Bonferroni methods. **Results:** A tendency towards increasing Schirmer's test values with higher filter densities was found; however, this change was not statistically significant in both normal (F=1.817, p=0.151) and dry eye groups (F=2.055, p=0.113). On the other hand, dry eye patients reported significantly more comfortable and more relaxed computer work with all filter densities (F=11.354, p=0.000), when in contrast, this response was statistically insignificant in the normal group (F=1.108, p=0.351). **Discussion:** Wearing blue light blocking filters has no significant effect in improving tear production in both normal and dry eye patients. More importantly, in the latter group, a perceived improvement in CVS-related complaints is clearly seen. Blue light filters therefore can be worn to improve comfort; although it must be done judiciously to avoid inadvertent changes to other physiological functions.

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Key words: Dry eye, CVS, blue light filter, Schirmer's test, ocular complaints

1. Introduction

Dry eye syndrome has been recognized as a growing public health problem among ethnic Chinese, with a prevalence of 21 to 50.1% in adults,[1-3] and 60 to 80% in older population.[4] Similar findings have also been reported in the US[5-6] and Japan.[7-8] The symptoms of dry eye or keratoconjunctivitis sicca are essentially ocular complaints that include reflex tearing, burning or stinging, grittiness, foreign body sensation, blurred vision, photophobia, and even asthenopia.[9-11] These symptoms can negatively affect a patient's quality of life.[12-18] While dry eye per se is fundamentally inflammation resulting from Meibomian gland dysfunction, it can be further exacerbated by various physiological and environmental factors. Among the latter is the increasing use of computers of various forms, leading to a myriad of symptoms, collectively known as computer vision syndrome (CVS). It is estimated that as high as 90% of computer users suffer from CVS including not only dryness of the eye, but also accommodative fatigue, diplopia, and decreasing visual acuity. The underlying factors of CVS are known to be reduced blinking rates and excessive dark accommodation during prolonged attentive computer work.[9, 16, 19] More recently, it is becoming clear that excessive exposure to the high-energy visible including blue light emanating from the displays of computers, laptops, tablets, smart phones, and televisions, may also be associated with eye strain.[8, 19] In fact, because of the ocular effects, the blue light component may be directly involved in the manifest of CVS. Current understanding is that while natural blue light during daylight hours is necessary for boosting attention, mood, and shortening reflex reaction times,[20,21] artificial blue light can quickly elicit ocular responses, such as ciliary muscle contraction[22,23] and pupillary constriction.[24] Which, when sustained, can also result in or add to ocular discomfort and fatigue. Also, by passing through the cornea and the crystalline lens unabsorbed, natural and the more direct artificial blue light can both reach and eventually injure the retina.[25]

Dry eye is one of the most common complaints encountered in the eye clinics. The efficacy of medical treatment has been based on physiological evaluation such as improvement in corneal epithelial healing and/or tears film stability.[9-11] On the other hand, it is reasonable to assume that by blocking the artificial blue light emitting from computer displays through the use of filters, ocular discomfort may also be lessened, at least in part. The purpose of the present study is therefore to investigate specifically if wearing blue light filter lenses improves dryness of the eye and relieves CVS-related ocular complaints.

Twenty dry eye patients (or the dry eye group, mean age=45.3±3.33 years, 10 males and 10 females), diagnosed with a baseline Schirmer's test of <10mm (mean=5.35mm), and twenty more patients (or the normal group, mean age=46.1±2.88 years, 10 males and 10 females) with normal Schirmer's test values (mean=13.15 mm) participated in the study. The study had received approval from the Institutional Review Board through an expedited process as one that posed minimal risks to the participants. The subjects were free from accommodation lag, with no other eye diseases and a habitual near and medium Snellen visual acuity of no worse than 0.8. All participants used their own prescription spectacles during daily activities and also for the two-hour experimental computer work during this study.

Wrap-around goggles with blue light filters of three densities, low, medium, and high, were sequentially worn during daily computer work, each density for one week. At the end of each week, and after two hours of continuous computer work on the last day, Schirmer's test was performed. For this two-hour testing period, room temperature, humidity, LED display specifications (21-inch monitor size, LED brand, and 1024 x 768 resolution) were fixed. In addition, ocular complaints were recorded via a questionnaire with a grading of 0 to 2 (with 0 being "very uncomfortable", 1 being "uncomfortable" and 2 being "comfortable"). The questionnaire included (1) eye strain, (2) watery eyes, (3) burning sensation, (4) ocular grittiness or pain, (5) blurred vision, (6) photophobia, (7) dizziness, and (8) headaches. The validity of the content and the reliability of questionnaire completion were also assessed. And the results showed that the test-retest reliability r= 0.995 and the internal consistency reliability Cronbach α=0.915.

Data were then analyzed with ANOVA and Post Hoc Bonferroni methods by using the SPSS 18 package (Data Statistical Analysis Corporation, Taipei, Taiwan).

Results

The descriptive statistical results of the Schirmer's test and ocular complaints are shown in Table 1. There appeared a tendency of increasing Schirmer's test values with higher filter densities among normal (mean of Schirmer's test values ranged from 13.150 to 14.325) and dry eye patients (mean Schirmer's test values ranged from 5.350 to 7.125) (see also Fig 1). Furthermore, ocular complaint scores also showed a steady progression in normal (mean of ocular complaint scores ranged from 10.70 to 12.10) and dry eye patients (mean of ocular complaint scores, from 5.10 to 7.65) (see also Fig 2). Changes in Schirmer's test values were not statistically significant in both normal (F=1.817, p=0.151) and dry eye groups (F=2.055, p=0.113) (Table 2). However, the dry eye patients reported significantly more comfortable and more relaxed computer work with all filter densities (F=11.354, p=0.000). In contrast, this response was statistically insignificant in the normal group (F=1.108, p=0.351). Post Hoc Bonferroni confirmed that dry eye patients did show a significant difference between the baseline and when wearing all three filters; although no correlation with the filter densities was noted.

4. Discussion

Our results show that wearing blue light blocking filters has no significant effect in changing tear production in both normal and dry eye groups. Importantly, however, a perceived improvement in CVS-related complaints is clearly seen in the dry eye group. While the placebo effect cannot be totally discounted, one possibility is the reduced blue light irradiation may also decrease irritation to the nerve endings of moderately to severely desiccated corneas. The improvement in ocular comfort therefore can be the interplay of blue light blocking and other yet-to-be identified factors than ciliary muscle contraction and pupilary constriction. Additional studies will be needed.

It would appear that to improve the comfort of computer users suffering from dry eye, blue light filters may be helpful. Although it should also be noted that since blue light is both beneficial and harmful at the same time, blocking of blue light may prove therapeutically effective only if done judiciously, or risk disruption of, for example, internal body clock function as it may suppresses the secretion of sleep-inducing melatonin.[26-29]

Table 1. Descriptive statistics of Schirmer's test and ocular complaints.

			N	Mean	SD	95% CI Upper	95% CI Lower
Normal patients	Schirmer's test	Baseline	20	13.150	1.9541	12.235	14.065
		Low density filter	20	13.425	2.0601	12.461	14.389
		Medium density filter	20	14.175	1.7112	13.374	14.976
		High density filter	20	14.325	1.8229	13.472	15.178
		Total	80	13.769	1.9208	13.341	14.196
	Ocular complaints	Baseline	20	10.70	2.494	9.53	11.87
		Low density filter	20	11.35	2.815	10.03	12.67
		Medium density filter	20	11.50	2.373	10.39	12.61
		High density filter	20	12.10	2.024	11.15	13.05
		Total	80	11.41	2.448	10.87	11.96
Dry eye patients	Schirmer's test	Baseline	20	5.350	2.5189	4.171	6.529
		Low density filter	20	6.625	2.4380	5.484	7.766
		Medium density filter	20	6.900	2.6587	5.656	8.144
		High density filter	20	7.125	2.2704	6.062	8.188
		Total	80	6.500	2.5246	5.938	7.062
	Ocular complaints	Baseline	20	5.10	1.619	4.34	5.86
		Low density filter	20	6.65	1.755	5.83	7.47
		Medium density filter	20	7.35	1.387	6.70	8.00
		High density filter	20	7.65	1.226	7.08	8.22
		Total	80	6.69	1.783	6.29	7.08

Table 2. Inter- and intra-group changes in Schirmer's test values and ocular complaint scores.

			SS	df	MS	F	P value
Normal patients	Schirmer's test	Between Groups	19.509	3	6.503	1.817	0.151
		Within Groups	271.963	76	3.578		
		Total	291.472	79			
	Ocular Complaints	Between Groups	19.838	3	6.613	1.108	0.351
		Within Groups	453.550	76	5.968		
		Total	473.388	79			
Dry eye patients	Schirmer's test	Between Groups	37.775	3	12.592	2.055	0.113
		Within Groups	465.725	76	6.128		
		Total	503.500	79			
	Ocular Complaints	Between Groups	77.738	3	25.913	11.354	0.000
		Within Groups	173.450	76	2.282		
		Total	251.188	79			

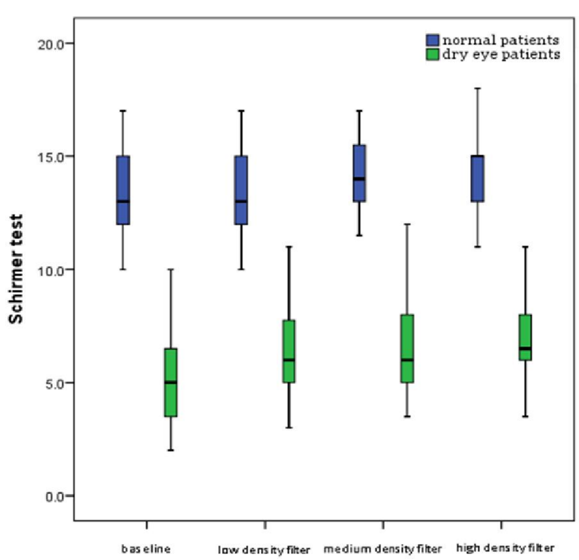

Fig 1. Box-plots of different filter densities vs Schirmer's test values.

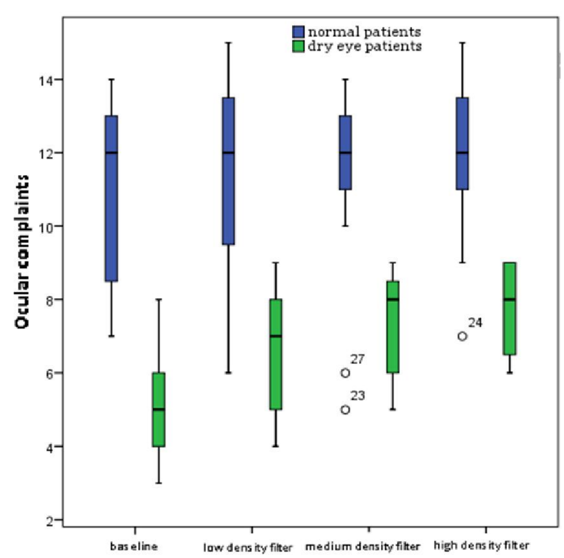

Fig 2. Box-plots of different densities vs ocular complaint scores.

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