Lower tear meniscus in computer reading task with and without soft contact lens

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ABSTRACT

Dry eye is the major contributor to computer vision syndrome. The reductions in the blink rate and amplitude have been considered as the possible mechanisms leading to this condition. The purpose of this study is to evaluate the changes in the lower tear meniscus heights and areas in the computer reading task, in dry eye subjects, with and without soft contact lenses. In this quasi-experimental study**,** 39 subjects (with mean age of 21.2 ± 2.4 years), with dry eye, were enrolled. The lower tear meniscus height and area (TMH, TMA) of the right eye was captured by Spectral Optical Coherence Tomography before and after 45 minutes of reading task behind desktop 17" Cathode Ray Tube monitors. The same procedure was performed after the insertion of the hydrogel soft contact lenses with 58% water content. The results of TMHs, TMAs were analyzed with a repeated measures analysis of variance (ANOVA) with two within-subject factors.**:** The mean ± standard error of TMH and TMA pre and post computer tasks were 283.6± 25.4 µm, 0.029±0.005 mm2, 297.6±20.7 µm , 0.036 ± 0.005 mm2 respectively. After contact lens insertion, the mean TMH and TMA pre and post computer task were 231.6 ± 10.6 µm, 0.020±0.0019 mm2, 213.0±9.0 µm, 0.018 ± 0.0011 mm2, respectively. Repeated measures analysis of variance showed that the changes in TMH (P=0.86) and TMA (P=0.37) after computer task, were not statistically significant, while the insertion of the soft contact lens had reduced the TMH and TMA significantly (P<0.001 for both). After 45 minutes of reading task behind desktop monitors, the tear volume has not changed, with and without high water SCLs. A reduction in tear volume might be expected with longer duration of computer task or at late hours of the day. The creation of a more stable tear film should be considered in the management strategies for shorter duration of work behind desktop monitors.

Keywords: Computer Vision Syndrome; Dry eye; Lower tear meniscus; Soft Contact Lenses.

INTRODUCTION

Computer Vision Syndrome (CVS) is a collection of symptoms associated with the use of computers [1-3]. These symptoms include eye irritation, burning sensation, redness, blurred vision and eye strain [2-3]. The reviews on the subject reveal that the major contributor to this condition appears to be dry eye [2-3]. However, the exact physiology of this vision syndrome is not well understood. A better understanding of this condition would lead to better management strategies.

Blink rate and blink amplitude have been investigated as the main mechanism responsible for the creation of this condition. Previous investigators have observed a decreased blink rate during computer operation 4-6 specially with increased cognitive demand of the task [7-8]. The other studies have reported a reduction in the amplitude of the blink during computer operation [7, 9-10]. A pre-existing dry eye condition might be exacerbated by computer operation. Dry eye subjects usually exhibit a higher blink rate in compare to normal subjects but both groups show lower blink rate following high demand visual task behind monitors (game and letter task) [7]. But the interaction between blink process and tear film parameters appears to be complex. Some investigators have shown that both tear meniscus heights are decreased in dry eye subjects in compare to normal [11]. The status of tear meniscus is not clear in dry eye subjects post computer tasks. Recently, Spectral Optical Coherence Tomography (SOCT), a more

advanced variant of OCT, has provided a non invasive technique to measure tear meniscus height with improved sensitivity and shorter duration of time [12]. Due to the placement of desktop monitors at primary gaze and partial blink while working with these monitors, it is speculated that lower tear meniscus is more prone to change. In this study we decided to assess changes in the lower tear meniscus before and after computer reading task by SOCT. In addition, it has been proposed that SOCT provides a clear picture of tear meniscus over contact lenses [12]. Lower tear menisci in lens wearers and non lens wearers have been evaluated by SOCT in the previous studies [12]. Since the application of soft contact lenses (SCLs) on the surface of cornea in non lens wearers can stimulate blinking and the mechanical irritation can induce reflex tearing, we decided to observe the changes in tear meniscus post insertion of soft contact lenses before and after performing a computer reading task.

MATERIALS AND METHODS

In this quasi-experimental study, the subjects were examined in three sessions. In the first week only their tear break up time was measured using Lowther's technique; the fluorescein strip (Elham Teb Co) was moistened with non-preserved saline, and excess fluid was shaken from its surface. The strip was gently touched to the superior bulbar conjunctiva or lid margin taking care not to instil too much solution or cause excessive reflex tearing. The patients were instructed to blink two or three times naturally and then after one closure try to keep the eyes open. The time from the opening until the appearance of first dry spot was measured.13The measurements were taken by one experienced examiner three times and the average was calculated. The subjects with TBUT $\leq$ 10 seconds meeting the criteria for dry eye were enrolled into the study. The other inclusion criteria were: no history of contact lens wear, refractive error $< \pm$ 1.00, lack of present spectacle, and lack of any other ocular surface disease. Informed consent was obtained from each subject in accordance with the tenets of the Declaration of Helsinki. A total of 39 students from Shahid Beheshti University of Medical Sciences, Faculty of rehabilitation meeting the above criteria were enrolled in this study. The participation of the subjects was approved by the ethical committee in Shahid Beheshti University of Medical Sciences.

In the second session, in the second week, the lower tear meniscus of the right eye was imaged by SOCT, RTVue 100 Fourier domain OCT (RT 100-1: Optovue Inc, Fremont, CA). All of the measurements were taken by one experienced examiner. The CAM-L was placed on the SOCT and the subject was instructed to view straight ahead while blinking normally. Sixteen continuous images were taken at the central lower lid. Only the right eye was selected to avoid reflex tearing behind the instrument due to long duration of staring. Then the subjects were instructed to work at computer stations with Cathode Ray Tube (CRT) 17 inch LG monitors. Their task was to search online articles related to their field of interest in optometry for 45 minutes continuously. Then, their tear menisci were imaged again by SOCT as described above. Since there is diurnal variation in the inferior tear meniscus14, all of the measurements were taken between 12:00 to 14:00 o'clock. The best image showing the hyper-reflective edges of the tear meniscus for each patient was selected by the operator. Then the images were magnified 8 times, and then using the rulers in the software the height and the area of the meniscus was outlined (Figure 1).

In the next session, the subjects were fitted with a pair of ultra vision disposable hydrogel cosmetic, plano, soft contact lenses (SCLs) whose materials were 42% HEMA, MAA copolymers, with 58% water. The fit of the lenses were checked with slit lamp bio-microscope. The subjects with excessive lens movement were excluded from the study. The lenses were left in the eye for a period of 1-2 hours adaptation period, to eliminate excessive tearing upon insertion. The subjects were instructed to work with the computer for 45 minutes and their tear menisci images were measured post computer work as described above (Figure 2). The Statistical Package for Social Science (SPSS; windows version 18) was used. Using the results of the pilot study

measuring TMH, TMA considering α= 0.05, and β=0.1 (power= 0.9) the sample was determined to 39 subjects. The results of TMH, TMA, and TBUT were analyzed with a repeated measures analysis of variance (ANOVA) with two within-subject factors. P-values less than 0.05 were considered as significant.

RESULTS

Thirty-nine subjects (with mean age was 21.2 ± 2.4 years, 59% women and 41% men were enrolled in this study. The mean TBUT in the right eyes were 7.6 ± 3.6. The results of tear meniscus height measured in the right eye without and with SCL pre and post computer use are presented in Table1 and Figure 3. Repeated measures analysis of variance showed that working with computer had no statistically significant effect on TMH (P=0.86), while insertion of SCL had reduced the TMH significantly (P<0.001). The interaction was not statistically significant (P= 0.25).

The results of tear meniscus area measured for right eyes without and with SCL pre and post computer use are presented in Table2 and Figure 4. Repeated measures analysis of variance showed that working with computer had no statistically significant effect on TMA (P=0.37), while the insertion of SCL had reduced the TMA significantly (P<0.001). The interaction was not statistically significant (P= 0.12).

Table 1. The statistical indices of TMH before and after computer work with and without SCL

SCL	Computer work	Mean of TMH (µm)	Standard error
Without SCL	Before	283.6	25.4
	After	297.6	20.7
With SCL	Before	231.6	10.6
	After	213.0	9.0

Table 2. The statistical indices of TMA before and after computer work with and without SCL

SCL	Compute r work	Mean of TMA(mm2)	Standard error
Without SCL	Before	.029	.005
	After	.036	.005
With SCL	Before	.020	.0019
	After	.018	.0011

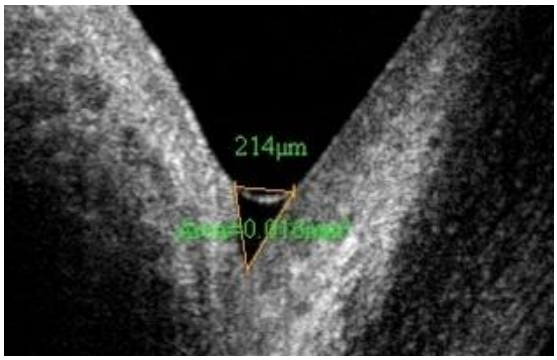

Figure 1. The image of Tear Meniscus Height(TMH) and Tear Meniscus Area TMA, without SCL

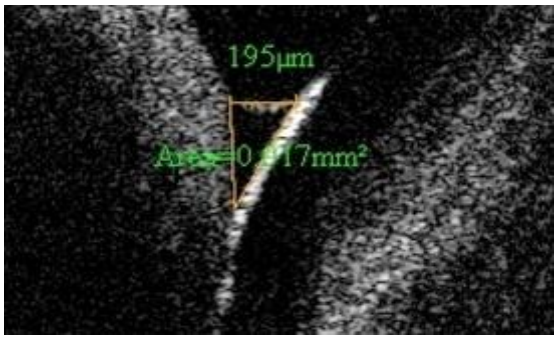

Figure 2. The image of Tear Meniscus Height(TMH) and Tear Meniscus Area TMA, with SCL

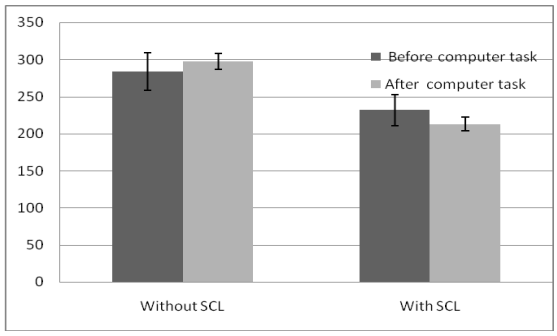

Figure 3. The mean of TMHs (µm) without and with SCL before and after computer work

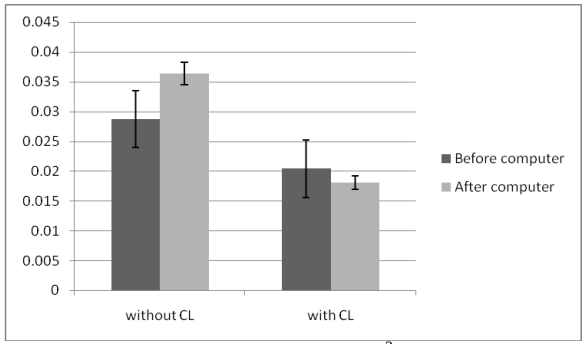

Figure4. The mean of TMAs (mm^2) without and with SCL before and after computer work

DISCUSSION

This study demonstrates that in dry eye subjects, after 45 minutes of reading behind the desktop monitors the LTMHs, and the LTMAs, have increased slightly, but not significantly. The slight accumulation of tear at the lower lid margins could have been due to the reduction of the number of blinks and incomplete lid closure which have been reported in previous studies [6-7, 9]. The possible mechanism is that ffollowing partial blinking in dry eye subjects, the superior lid distributes the fragile tear film over the central cornea; The breaks in the tear film happen in the inferior portion of the cornea, where more corneal staining has been noted, and the lower tear meniscus acts as more of a reservoir to collect the excess tears [11].

This study demonstrates that when SCLs were worn in compare to when no soft lenses were worn, LTMHs and LTMAs were both reduced significantly ($P<0.001$). This reduction in tear menisci could have happened due to any of the following reasons: 1) a more rapid rate of tear evaporation from the SCLs surface, 2) the absorption of tear by the high water content SCLs or 3) the reduction in the space between the ends of the tear meniscus due to the forward displacement of the referenced surface (the SCL surface versus the corneal surface). The first reason is a strong possibility because the other investigators have also reported a rapid pre lens tear film thinning time with the high nominal water content lenses [15]. The third reason is still a possibility. In contrary to our results, the other investigators [12] have reported that the forward displacement of the lens on the corneal surface does not influence LTMH. This contradiction with our finding could be due to the fact that they have measured LTMH after lens removal not following lens insertion. Some volume of tear could have been absorbed by the SCL after wearing the SCL for some time. The result of this study shows that, after 45 minutes of computer work, with high water content SCL, TMH, TMA values did not change significantly. With no lens wear, post VDT use, TMH was increased slightly, while after lens wear, post VDT use, TMHs were decreased slightly. These findings might be due to the absorption of water by the high water SCLs or due to rapid evaporation of tear on the SCL surface.

In this study, despite the fact that the SCL were worn for the first time, the constant stimulation of the lids and corneal surface did not increase tear volume. Other investigators have reported that the frequency of blinking increased with CLs even when the subjects played computer games [8, 16]. But the symptoms were increased. The increases in the symptoms were correlated with the reduction in the blink amplitude and with less stable tear film over the area of pupil [8]. In additions, in another study, the attempt to increase the blink rate by means of audible tones has not produced a significant change in dryness symptoms [9]. With SCL wear, the reduction in the pre lens tear volume and more instability of the tear film over the SCL surface appears to overrides the impact of increased in blink number. Therefore, it is not favourable to use SCL in the management of dry eye condition in CVS. This study demonstrates that 45 minutes of reading task behind desktop monitor does not alter the lower tear meniscus in the dry eye subjects. The change in volume might be expected with longer duration (at least three hours of work) behind monitor as it has been reported by investigators [17]. The change might be more clinically significant towards the end of the day when the inferior tear meniscus has been reported to reduce significantly due to diurnal variation [14]. The stability of tear film appears to be a more important parameter that should be addressed in future studies. In the management strategies, instead of just increasing the volume in the lower meniscus, the creation of a more stable tear film is recommended.

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