ARTICLE TYPE

Influence of visual display near task (VDNT) on the blink rates (BR) and dry eye symptoms among soft contact lens wearer

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Abstract:

This article studies the effect of the visual display near task (VDNT) on blink rate (BR) among soft contact lens wearer and the association between blink rates with the symptoms of dry eye in habitual contact lens wearer. Eighteen participants (mean age: 22.1±1.6 years) were recruited in this study. All participants were adapted soft contact lens wearer with low to moderate power (0.00D to ≤ -6.00D). Dry eye symptom questionnaire (CLDEQ-8) was given to each participant and asked to answer prior to the study. Blinking were then captured for 23 minutes which comprised of 3 minutes before VDNT with a 3-meter target (as baseline measurement) and another 20 minutes during VDNT at 40 centimetres. Blinking was counted by stopwatch when the ocular surface area fully covered by the upper eyelid. The Blink Rates for 1 minute was calculated from the average. The total point of CLDEQ-8 were correlated with the blink rates in both conditions. The mean of the blink rates before VDNT 23.5 blink/min (SD± 9.09 blink/min) higher than the mean of the blink rates during VDNT 11.4 blink/min (SD ± 5.03 blink/min). The mean difference of both conditions was statistically significant $p < 0.05$ and the 95% confidence interval (CI) was 12.15 (8.767-15.539). The weak positive correlation of dry eye symptoms and the blink rates before VDNT, r=0.104 (p=0.682) and during VDNT, r= 0.142 (p=0.573). There was no significant of dry eye symptoms and both blink rates, respectively. The blink rate/min was affected during visual display near task among soft contact lens wearer. The blink rate reduced significantly during VDNT. A good selection of subjects can influence the correlation between dry eye symptoms and blink rates. However, this study agreed that both contact lens and VDNT could be the factors that contribute to the tear film instability due to less endogenous blinking occurred when more attention required by the task.

Keywords: blink rates, contact lens wearer, visual display near task, dryness

1. INTRODUCTION

A smooth ocular surface, tear film, lacrimal gland and the eyelid maintains a good quality of refractive error. Aqueous humour is a component in the eye that nourishes the anterior cornea and produce biochemical metabolites [1]. Tear film and its production is a functional unit structure that responsible for maintaining the health of ocular surface from dehydration. It also functions as the first line of defence in resisting injury and protects the eye against body changes and surrounding condition. Generally, tears component is divided into three layers which are mucin, aqueous and lipid. The lipid layer is the outermost of tears film secreted by the meibomian gland that holds back the excessive of tears evaporation [2]. These tears film also called pre-corneal tear film (PTF). Dry eye and complaints of eye symptoms always associated with PTF instability. The symptoms arise when any of the tears film layer being disturbed. Obstruction of meibomian gland distribution accompanied with decreased tears secretion from lacrimal gland cause increased evaporation of tears from the ocular surface. This contributes to the inadequate moisture of PTF; therefore, dry eye symptoms may experience [3]. It is reported that the lipid layer qualitatively manifest when it cannot hold the tears from break-up [2].

Dry eye symptoms can be symptomatic and asymptomatic. Hence, the complaints can be due to several factors such as thermal factor, task demand and the individual eye condition. Thermal factors arise from low humidity and high temperature. High demand on the near task such as playing video games may cause a reduction in blink rate due to the wide exposure of ocular surface. The blink rate of dry eyes patient also declines with the alteration of the tear film, gland dysfunction, blinking anomalies and especially for the contact lens wearer [4].

The contact lens has become a successful treatment due to its function as optical correction and cosmetic reason [5]. It is now becoming more popular in younger population especially among college, university students and young adults. The contact lens has proved to provide convenience, increase availability, affordability with increase of the quality of life (QoL) [6]. The contact lens has given benefit in providing a wider visual field and improves aesthetic of a person compared to glasses [5]. However, dry eye is the main eye symptoms reported among contact lens wear. When contact lens is inserted on the ocular surface, tear film become altered, and contact lens divided tear film into pre-lens tear film (PLTF) and post-lens tear film (PoLTF). Pre-lens is defined as the distance of air surface from contact lens surface while post-lens tear film is the distance of lens back surface to the cornea. The mechanism of dry eye due to contact lens can be direct and indirect. Direct mechanism stimulation altered meibomian gland; thus, PoLTF becomes thin as the friction between the back contact lens and cornea/conjunctiva increase. Hence, cause dryness, foreign body and discomfort sensations. Indirect mechanism caused alteration of the aqueous layer in PLTF and reduced its volume thus become unstable and easily breakable within a short period of blinking. This correlates when contact lens wettability is not enough to cover the corneal surface as lacking in hydrophilic mucin layer [7-8].

PLTF has reduced tear volume, reduced lipid layer thickness, and increase evaporation rate compared to the normal tear film [9]. Regarding the tear film alteration, contact lens has highly associated with contact lens discomfort (CLD). It is a common symptom of ocular discomfort which presented among contact lens wearers such as fatigue, irritation dryness, excessive tearing and red-eye. This symptom becomes more severe as the wearing increase over the day [9]. It also becomes more evident as the lens ageing in monthly or conventional disposable contact lens, particularly lenses with ionic polymers. Consequently, lens dehydrated quickly on ocular surface cause blurriness and unstable vision due to the accumulation of protein deposits [10]. Hence, Contact Lens Dry Eye Questionnaires (CLDEQ-8) was developed to describe symptoms among contact lens wearer. It is a global opinion with 8 questions that evaluate dryness, discomfort, blur of vision and desire to remove contact lens [11]

Eighty-four percent of the world population had use visual display unit by the end of 2018 in their daily life [12]. Viewing electronic display has become a significant part of daily living at home, work and during leisure time [13]. The visual display unit can be in many forms such as tablet, desktop, computer, and smartphone. By giving full attention for prolong time on VDNT such as playing video game induce high cognitive demand that causes in deterioration of the ocular surface tear film [14]. Besides, action type of video games with 3D complex settings, feature quickly moving targets that pop in and out of view, necessitate substantial visual processing of the periphery, and include large amount of clutter and irrelevant task objects. This game requires the player to consistently switch between highly focused and highly distributed attention, to make a rapid and accurate decision. Hence, a high level of a cognitive task being introduced [15]

Blinking rate is defined as blink per minute. Blinking is an important mechanism in tears distribution and drainage. It also helps to keep maintaining equilibrium of the tear volume on ocular surface and in conjunctival sac [16]. There are three types of blinking which are reflex blinks, voluntary blinks and endogenous blinks [17]. In measurement of blink rate, it includes complete and incomplete blinks. Complete blink defined by a downward movement of upper eyelid covering more than 75% of the cornea while minor twitches of upper eyelid covering less than 30% hence incomplete blinks was counted as upper eyelid covering cornea between 30% to 70% [18]. The regular blinking pattern in rest position can be altered by activity and eye gaze which affect the function of the tear [19]. Viewing task in downward gaze such as smartphone cause reduction in blinking [20]. VDNT can also be categorized in low and high cognitive demand. The study showed there is significant low blink rate with high visual demand [14]. The mean blinking rate in a relax position was 22 blinks/min, and then it reduces to 10 blink/min with viewing book and 7/min with viewing screen [13]. Hence, while viewing screen, the internal controls have been introduced over blinking to minimise task from being interrupted by the upper eyelid [21].

VDNT and contact lens has proved to influenced tear film instability [7-8]. The average of the spontaneous blinking rate can be altered with different level of VDNT, emotional states and mental activity however with contact lens, and it helps to maintain the normal tear film, optical quality and hydration through the interchange of tears between contact lens and cornea [22]. Meanwhile, while playing video game, tears film instability will increase, and cause blinking rate to be increased frequency with fully adapted soft contact lens due to the adequate extrinsic ocular surface stimulation which overrides the internal controls and the blinking parameters [23]. Nevertheless, the blinking amplitude has decreased significantly with contact lens while playing video games with correlation of dry eye severity [24]. However, it reaches agreement when adapted contact lens provides sufficient ocular surface or lid stimulation to increase blinking rate. Incomplete blinking can influence inefficient blinking with contact lens wear which leads to ocular surface staining and dry eye symptoms as tears are not distributed normally and inferior cornea being exposed [23]. Therefore, the aims of this study to evaluate the blinking rate among soft contact lens wearer during VDNT (playing video games) and to evaluate the correlation between blink rate before and during VDNT with the dry eye symptoms (CLDEQ-8).

2. METHODOLOGY

Eighteen subjects (mean age: 22.1±1.6 years) participated in this study. Ethical approval was obtained from UiTM Research Ethics Committee. All subjects were given informed consent and have passed screening test, adapted with soft contact lens low to moderate power (0.00 to ≤-6.00D) whether daily disposable contact lens or monthly contact lens and best-corrected visual acuity with contact lens was ≤6/9. No subject had any history of ocular disease, eye infection and contact lens complication before. Before the experiment (~10 minutes), all subjects inserted their habitual contact lens. During this adaptation period, the purpose and the flow of the experiments were explained while the participants signed the consent form, fill in the demographic data, and answered CLDEQ-8 questionnaires. (Contact Lens Dry Eye Questionnaires). CLDEQ-8 is a simple questionnaire with scoring system to measure dryness symptoms among contact lens wearer, consist of 5 sections of 8 questions which are related to discomfort, dryness, blurred vision, and desire of removing contact lens which gives a total score of 37 points.

Refer to the previous study, and contact lens wearer were classified as symptomatic dry eye if the total score was ≥ 12 points [25].

Adaptation period was provided to ensure comfortability and to obviate reflex tearing that contributes to excessive rate of blinks [26]. Subjects were required to play a video game as visual display near task (VDNT) while blink rates being recorded. A pilot study has been done with repeated measurements of blink rates before VDNT with 2 minutes, 3 minutes and during VDNT with 10 minutes, 15 minutes and 20 minutes. The blink rates were significant with 3 minutes VDNT and 20 minutes during VDNT. Two conditions were required: one to evaluate blink rates in a relaxed position for 3 minutes as a baseline and the other to evaluate blink rates while playing a video game (iZUmas Oya Faction Version 4.2) from an IPAD for 20 minutes. Both tasks were performed under the same ambient lighting (1145 lux) and environmental condition (22-27ºC) and at the same playing distance (40cm). The IPAD had a screen size of 7.9 inches and a resolution of 2048 x 1536 pixels. To avoid internal control in natural blinking pattern and forced blinking, subjects were not told to that blinking were analysed. Subjects' blink rates were recorded for 3 minutes before VDNT and were asked to relax and direct their gaze toward distance target (3m) as for the baseline measurement. Subjects were then asked to play a video game (during VDNT) for about 20 minutes with the blink rates been recorded. Video of the blinking was recorded using a digital camera, Nikon DSLR 45.7 Megapixels. Blinks were counted by stopwatch when the ocular surface area fully covered by the upper eyelid. The Blink Rates for 1 minute was calculated from the average.

Statistical analysis was conducted using the Statistical Package for the Social Science (SPSS) software for Windows version 21.0. Normality test was done using the Kolmogorov-Smirnov test. For parametric data, data was analysed using Paired sample t-test to compare the difference of the blink rate (per/min) before VDNT and during VDNT. A p-value of less than 0.05 denoted as statistically significant. The correlation between dry eye symptoms and before VDNT and after VDNT were derived using Pearson's correlation test for data with normal distributions.

3. RESULT AND DISCUSSION

3.1. Blink Rate

The mean difference of the blink rates before and during visual display near task (VDNT) was statistically significant $p<0.05$. The mean of the blink rates before was 23.5 blink/min (SD±9.09 blink/min) while the mean of the blink rates VDNT was 11.4 blink/min (SD±5.03 blink/min [Table 1] The mean for the blink rate during was lower than before VDNT.

The mean difference for both conditions was statistically significant, $p< 0.05$, with a 95% confidence interval (CI), 12.15 (8.767-15.539).

Table 1: Change of the blink rate/min with DVNT

	Blink rates/min before and during VDNT mean (SD)			
	Before	During	Mean Difference	t-stat (df), p value
Blink Rates (blink/min)	23.5 (9.09)	11.4 (5.03)	12.15 (8.76-15.54)	7.57 (17), <0.05

The blink rates were reduced significantly while playing video games among soft contact lens wearers in which video game has to induce high attention demand that causes reduction in blinking due to information processing as well as to minimise the eyelid distraction in prolonged attention period [27-28]. Besides, internal control like cornea sensitivity and visual disturbance is believed to slow down the blinking to enhance attention [28]. This is because playing video games required quick to respond to the important stimuli as the game's features could be confusing from the backgrounds such as contrast, visual acuity and crowding effect [17]. Downward gaze position with visual display near task also influence blink rates to decrease due to less tear evaporation with the decrease in the exposed ocular surface area [20] However, the blink rates has proved to significant increase in fully adapted soft contact lens because enough support by extrinsic ocular surface and lid stimulation to revoke internal controls and also maintain relative rate of blinking [23]. Besides affecting the blink rates, both VDNT and contact lens insertion has contributed to the poor tear stability [7]. This may due to the alteration in tear film with meibomian gland dystrophy, which degraded the lipids that lower the mole percentage of wax esters in the tear film. Therefore, contact lens wearer is significantly associated with dry eye syndrome [12].

3.2. Correlation Dry Eye Symptoms and Blink Rate

A positive poor correlation of dry eye symptoms and the blink rates before VDNT, $r=0.104$ ($p=0.682$) and during VDNT $r=0.142$ ($p=0.573$) [Figure 1]. There was no significant correlation of dry eye symptoms and the blink rates before and during VDNT. The high and low score of dry eye symptoms had no significant correlation with the blink rates.

Besides affecting the blink rates, both VDNT and contact lens insertion has contributed to the poor tear stability [7]. This may due to the alteration in tear film with meibomian gland dystrophy, which degraded the lipids that lower the mole percentage of wax esters in the tear film. Therefore, contact lens wearer is significantly associated with dry eye syndrome [12]. Prolonged use of a soft contact lens caused hypoxia as it induced lens sensitivity [9]. The blink rates increase with contact lens due to ocular surface irritation that caused cluster in the blinking pattern and unstable tears especially to those who are new to contact lens [29]. When combining with VDNT, other signs and symptoms arise such as visual discomfort, asthenopia, reduce visual acuity with poor visual contrast [12]. There is also a correlation in an incomplete blink with the blink interval as it results in excessive tears evaporation with VDNT that also induce eyestrain [30].

Eyestrain symptoms do not improve with frequent blinking but improve with adequate ocular moisture. In prolong time of eyestrain, it eventually induces dry eye [31]

Contact Lens Dry Eye Questionnaires (CLDEQ-8) was used similar to the previous study done by Jansen et al (2010) which purposely to grade the severity of dryness symptoms among contact lens wearer. It is because contact lens wearer commonly reported dry eye symptoms and it is a subcategory of dry eye. Thus, CLDEQ-8 is one of the tools to provide wearer's worldwide opinion, review improvement and worsening of the overall opinion on their contact lens [25]. This study found that half of the subjects scored more than 12 points that classified as symptomatic dry eye. However, there was positive poor correlation of dry eye symptoms and the blink rates before (r=0.104) and during VDNT (r= 0.142) with p = 0.682, p= 0.573. Due to the good selection of subjects, CLDEQ-8 was not a good tool in this study as dry eye subjects were excluded. Besides that, this questionnaire is a combination with clinical signs such as corneal staining, low TBUT and poor Schirmer test, which increase sensitivity and specificity of diagnosis of dry eye [25].

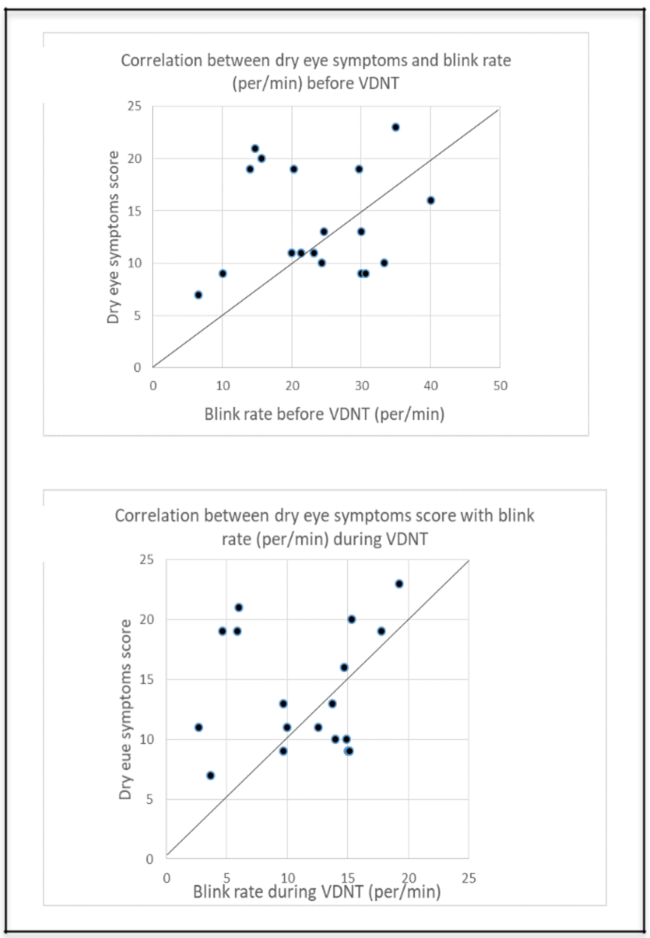

Figure 1: Correlation of dry eye symptoms and blink rates before and after VDNT

Nevertheless, this study had a limitation due to small population size. Further study was suggested with a more significant number of subjects that incorporate many different types of people, various contact lens power and materials, thus giving more reliable results. Besides, other questionnaires can be used such as Ocular Surface Disease Index (OSDI) which include the impact of dry eye symptoms on vision-related functioning in daily life [32].

4. CONCLUSIONS

The blink rate/min was affected during visual display near task among soft contact lens wearer. High cognitive demand task with increase concentration has introduced to the intrinsic control of upper lid distraction due to visual information processing. Good selection of subjects can influence the correlation between dry eye symptoms and blink rates. However, both contact lens and VDNT could be the factors that contribute to the tear film instability due to less endogenous blinking occur as more attention required by the task.

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