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Changes in the Dry Eye Parameters, Tear Meniscus Height and Corneal Epithelial Thickness in Long-Term Computer Users Over a Short-Term Working Week Period: Cohort Study

Uzun Süreli Bilgisayar Kullanıcılarında Kuru Göz Parametreleri, Gözyaşı Menisküs Yüksekliği ve Kornea Epitel Kalınlığının Kısa Süreli Hafta İçi Çalışma Periyodundaki Değişimi: Kohort Çalışması

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ABSTRACT Objective: To investigate the changes in dry eye parameters, tear meniscus height and epithelial thickness over a short-term period (working week) in long-term computer users. **Material and Methods:** There were 46 eyes of 23 patients with dry eye symptoms who used computers for at least 6 h per day were included in this study. The Schirmer's test scores, tear break-up time (TBUT), ocular surface disease index (OSDI) score, epithelial thickness and tear meniscus levels by spectral domain-optical coherence tomography were recorded. All measurements of the patients were repeated on Monday morning before starting work (first visit) and on Friday of the same week after work (second visit) without medication. **Results:** The mean TBUT values were 12.41±2.68 s, 9.69±2.39 s, the Schirmer's test values were 20±5.47 mm, 11.89±3.62 mm (p<0.001); the tear meniscus levels were 158.65±41.18 µm, 118.15±31.99 µm (p<0.001); the OSDI scores were 12.13±4.89, 18±5.50 (p<0.001); and the central corneal epithelium thicknesses were 33.5±5.81 µm, 33.19±6.10 µm (p=0.703) upon the first and second visit, respectively. There was no significant difference in central corneal epithelial thickness (CET) between the two visits (p=0.703). **Conclusion:** While changes in the OSDI score, the TBUT, the Schirmer's test score and the tear meniscus levels were observed in long-term computer users in the short-term working week period, there was no short-term effect on central CET.

Keywords: Computer user; dry eye; meniscus; corneal epithelial thickness

ÖZET Amaç: Bu çalışmanın amacı, uzun süreli bilgisayar kullanıcılarında kısa dönem (hafta içi dönem) kuru göz parametreleri, gözyaşı menisküsü yüksekliği ve epitel kalınlığındaki değişiklikleri araştırmak. **Gereç ve Yöntemler:** Günde en az 6 saat bilgisayar kullanan, kuru göz semptomları olan 23 hastanın 46 gözü çalışmaya dâhil edildi. Schirmer testi, gözyaşı kırılma zamanı (GKZ), oküler yüzey hastalığı indeksi (OYHİ) skoru, epitel kalınlığı ve gözyaşı menisküs seviyeleri spektral domain optik koherens tomografi ile kaydedildi. Hastaların tüm ölçümleri pazartesi günü işe başlamadan önce sabah (1. vizit) ve aynı hafta cuma günü iş çıkışı (2. vizit) ilaçsız tekrarlandı. **Bulgular:** GKZ değerleri 1 ve 2. vizitte sırasıyla ortalama 12,41±2,68 sn, 9,69±2,39 sn (p<0,001); Schirmer test değerleri 20±5,47 mm, 11,89±3,62 mm (p<0,001); gözyaşı menisküs seviyeleri 158,65±41,18 µm, 118,15±31,99 µm (p<0,001); OYHİ skorları 12,13±4,89, 18±5,50 (p<0,001); santral kornea epitel kalınlıkları 33,5±5,81 µm, 33,19±6,10 µm (p=0,703) idi. Santral kornea epitel kalınlığı açısından 2 vizit arasında anlamlı fark yoktu (p=0,703). **Sonuç:** Kısa süre hafta içi döneminde, uzun süreli bilgisayar kullanıcılarında OYHİ skoru, GKZ, schirmer ve gözyaşı menisküs düzeylerinde değişiklikler gözlenirken, merkezi kornea epitel kalınlığı üzerinde değişiklik yoktu.

Anahtar Kelimeler: Bilgisayar kullanıcısı; kuru göz; menisküs; kornea epitel kalınlığı

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Today, with the increasing use of computers in many areas, eye-related symptoms have increased.[1] The totality of computer-related eye problems (combination of vision and other eye problems) is now described as computer vision syndrome.[2] This term includes musculoskeletal symptoms as well as vision problems caused by prolonged computer use.[2] These symptoms may occur when a computer is used >3 h per day or >30 h per week.[2,3] Eye-related symptoms include eye strain, irritation, redness, burning, and blurred vision.[4]

Dry eye disease (DED) is frequently present in computer users.[1] Prolonged use leads to tear film instability by reducing the blink rate and the width of the blink.[5] The use of computer and imaging devices with a display not only reduces the number of blinks, but also causes the tears to evaporate, followed by DED. The most common type of DED is an evaporative type, and computer use is particularly important in this group.[6] The incidence of dry eye varies between 30% and 68.5%.[1,7] DED is diagnosed with anamnesis and examination findings, but there is no single gold standard and the diagnosis is made only by a combination of many tests.[8] Schirmer's test, tear break-up time (TBUT), ocular surface staining with sodium fluorescein, and the ocular surface disease index (OSDI) questionnaire are among the most commonly used.[9,10]

In recent years, the use of less invasive and even non-invasive methods to investigate the tear layer have come to the fore, and it has been revealed that these methods evaluate the tear layer as closely as possible to the "physiological" state.[8] Tear meniscus height has been found to be a good indicator when diagnosing dry eye in the case of aqueous tear deficiency because it measures most of its volume.[11] It is also advantageous that tear meniscus height measurement is non-invasive.[11] In recent years, another non-invasive measurement, corneal epithelial thickness (CET), has been evaluated to show the corneal anatomical change due to dry eye.[12]

Our aim in this study is to examine the changes in dry eye parameters, tear meniscus height and CET over a short-term (working week) period in long term computer users.

MATERIAL AND METHODS

The study is a prospective study. The study was performed in Kayseri City Hospital Eye Clinic in accordance with the Declaration of Helsinki. Twenty-three medical secretaries who presented with dry eye symptoms were included in the study. Written informed consent was obtained from each patient. Ethical approval was obtained from the ethics committee of Kayseri City Hospital (date/decision no: 18.03.2021/328).

There were 46 eyes from 23 participants using computers for a long time included in the study. The working group consisted of staff that work as medical secretaries in our hospital. Those with systemic diseases other than eye diseases, those who had had laser surgery, those who used eye medication, artificial tears or contact lenses, and those with eye diseases that could not be corrected with glasses were excluded from the study. Individuals included in the study had at least 6 h of computer use per day over at least 5 years. Participants were examined twice, once before starting work at 8:00 on Monday (the first day of the working week) and once at 17.00 on Friday (the last day of the working week). TBUT, the Schirmer's test results (with topical anaesthesia) and the OSDI scores, tear meniscus heights and CET were measured by anterior segment mode of optical coherence tomography at each of the two visits. The dry eye symptoms of the cases were evaluated with the OSDI questionnaire, which is a 12-item questionnaire that evaluates ocular symptoms due to dry eye and visual functions. The questions cover visual functions, ocular symptoms and environmental stimuli. The OSDI questionnaire consists of 12 questions and three parts, and the answers to the questions are scored between 0-4 according to the frequency of complaints. The value of the resulting OSDI score ranges between 0-100 and is directly proportional to the severity of the DED. In our study, in accordance with the literature, participants with an OSDI score below 13 were considered normal, while 13-22 was classified as "mild", 23-32 as "moderate" and 33-100 as "severe" dry eyes.[13,14]

The Schirmer's test was performed by drying the excess tear droplets after instillation of proparacaine

(proparacaine·HCl, Alcaine 0.5%, Alcon) and placing the Schirmer's test strip in the lateral part of the patient's lower eyelid. After waiting 5 minutes, the patient was asked to look ahead and blink normally. After 5 min, the Schirmer's test papers were removed and the tear volume was recorded. To determine TBUT, patients were asked to blink three times after fluorescein was dropped into their eyes, then open their eyes and look straight. With biomicroscopic examination under cobalt blue light, the time of loss of tear integrity and the formation of stains on the cornea were recorded.

Images of anterior segment was obtained by the Spectral Domain-Optical Coherence Tomography (SD-OCT) system (Heidelberg Engineering, Heidelberg, Germany) using vertical raster, single line, high-resolution scanning with the anterior segment module. All images were evaluated by a single ophthalmologist.

A 6 mm vertical line was used to measure the tear meniscus, based on the center of the cornea and crossing the vertical axis of the lower eyelid. The center of the cornea was determined as the middle of the two points referring to the medial limbus in the medial and the lateral limbus in the lateral. A central vertical line scan section image was obtained for the tear meniscus measurement (TMH). TMH was measured as the distance from the lower eyelid-meniscus junction to the cornea-meniscus junction (Figure 1).[15]

Measurements of CET were obtained with anterior segment module of an SD-OCT device via an additional lens and software. The device offers the ability to scan widths from 8 to 16 mm including single line and volume scans using OCT technology combined with a confocal scanning laser ophthalmoscope. We manually measured the CET using calibrated tools where we analysed the images at 800% zoom (Figure 2).

We examined the measurements of the epithelial thickness of the cornea at the central cornea (Figure 2). An experienced technician (SB) took images and the images were evaluated by an experienced clinician (EV). We tried to select the best quality results for analysis by repeating both exams and manual measurements at least three times.

STATISTICAL ANALYSIS

Statistical Package for the Social Sciences version 18.0 for Windows (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Shapiro-Wilk test was used to check whether the data were normally distributed. Descriptive statistics were expressed as mean± standard deviation. Values at 2 different visits were analyzed using the paired-t test. Pearson's correlation was used to assess the relationships between variables. Analysis were made at a 95% confidence interval, and differences were considered significant at $p<0.05$.

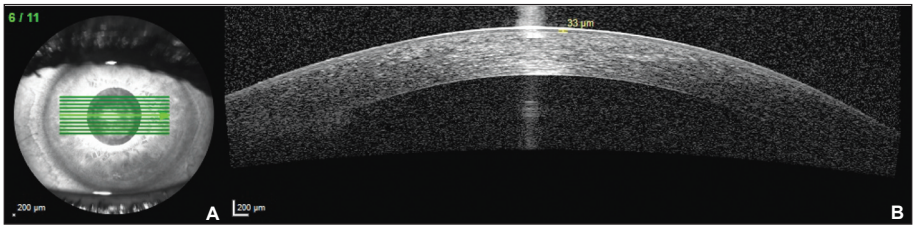

FIGURE 1: Anterior segment optical coherence tomography image of cornea is shown. **(A)** Measurement points, **(B)** Measurement of central corneal epithelial thickness.

FIGURE 2: Illustration of the measurements of the tear meniscus level height by anterior segment optical coherence tomography.

RESULTS

There were 23 patients (16 women and 7 men) included. From these 23 patients, 46 eyes were analysed. The average age of the patients was 29.17±4.24 years. The mean TBUT values were 12.41±2.68 s, 9.69±2.39 s; the Schirmer test values were 20±5.47 mm, 11.89±3.62 mm (p<0.001); the tear meniscus levels were 158.65±41.18 µm, 118.15±31.99 µm (p<0.001); the OSDI scores were 12.13±4.89, 18±5.50 (p<0.001); and the central corneal epithelium thicknesses were 33.5±5.81 µm, 33.19±6.10 µm (p=0.703) upon the first and second visit, respectively. Central CET was not statistically different between the two visits (p=0.703), (p=0.703). There was no correlation between the baseline OSDI score and the baseline Schirmer's test values, TBUT, tear meniscus height and CET.

In terms of all parameters, changes in the OSDI between the two visits were negatively correlated with the change in the TBUT (p=0.026, r=-0.327), while there was no correlation in terms of the change in other parameters (Table 1).

DISCUSSION

In our study, we observed that there were statistically significant changes in the tear parameters (TBUT, Schirmer's test score, OSDI score, and the TMH) over the 5-day working week (to exclude the weekend rest period) in long-term computer users using active computers, but there was no significant change in central CET.

The use of digital devices can cause ocular discomfort symptoms such as stinging, painful eyes, blurred vision, and DED. This happens because it disrupts ocular surface homeostasis and tear film function by affecting blink patterns.[16] A study of computer users in an office setting found that computer users' blink rate decreased compared to non-users and that computer imaging showed half the blink rate within minutes compared to before computer use.[17] Again, in a study conducted about workplace health, it was found that the possibility of developing dry eye increased by 89% in people who did not use a screen filter and took a short break during the study.[18]

DED diagnostic techniques may be based to detect abnormal tear film, such as the Schirmer's test or TBUT. Studies have shown a weak correlation between these tests and the patients' symptoms.[19] In our study, we could not see any correlation between the Schirmer's test, TBUT and OSDI scores, but we observed a significant decrease in the second visit compared to the first visit. In a study conducted with the hospital staff, there was a moderate positive correlation between the OSDI score and the duration of screen use.[20] In a study by Taşkıran et al., among all the tests in the dry eye patients, the Schirmer's test was positively correlated with TBUT and TMH.[8] Computer use reduces TBUT.[21] After playing computer games for as little as 20 to 60 min (both slow and fast), TBUT and lipid layer thickness decreased.[21] Computer users also experienced a decrease in TBUT after a routine workday, but not in non-users.[22] Another study showed that using computers for more than 4 h per day negatively affected the quality of meibum expression.[23] In our study, we observed that using a computer for at least 6 h per day for 5 consecutive days significantly reduced TBUT. A decrease in TBUT, which is a sign of this deterioration in tear stability in computer users, is also a sign of meibomian dysfunction.

DED causes ocular surface inflammation, tear film instability and tear hyperosmolarity.[24] Inflammation of the ocular surface damages both the conjunctiva and the corneal epithelial cells.

TABLE 1: Correlation between change in OSDI score and change in other parameters (Schirmer test, TBUT, TMH, CET).

	Change in schirmer test value	Change in TBUT value	Change in TMH value	Change in CET
Change in OSDI score value	p=0.514	***p=0.026**	p=0.486	p=0.853
	r=-0.099	**r=-0.327**	r=-0.105	r=-0.028

Pearson correlation test was used *p<0.05 was statistically significant. Bold value denotes statistical significance. OSDI: Ocular surface disease index; TBUT: Tear break-up time; TMH: Tear meniscus measurement; CET: Corneal epithelial thickness.

Damage to the corneal epithelium can cause clinical symptoms similar to those in DED.[25] Because of its high reliability and reproducibility, anterior segment OCT has been preferred in many studies to evaluate the corneal epithelium.[26,27] Studies have found different results regarding changes in CET in patients with DED. Fabianiet et al. found an increase in CET in a mouse model of dry eye and suggested that this may be due to an increase in epithelial turnover in chronic inflammation.[28] Liang et al. compared patients with DED to healthy controls in terms of central CET, bulbar conjunctival epithelium and limbal epithelial thickness. They reported that there was no difference in central CET, but the bulbar conjunctival epithelium was thick and the limbal epithelium was thin in the DED group.[29] Erdelyi et al. reported that CET tends to be thinner in dry eyes due to the loss of stem cells in the limbus.[30] In our study, we did not observe a significant change in CET in the short term, but we did not examine the change in other corneal regions.

Evaporative dry eye occurs in cases where blinking function is reduced (e.g., prolonged use of tablets, computers or blepharoplasty). In a study investigating the change in tear meniscus height after lower eyelid blepharoplasty, decreased blink function of the eye after lower eyelid blepharoplasty and a decrease in TMH due to evaporative dry eye was observed.[8] In our study, we observed a significant decrease in TMH at the end of the working week study period.

The limitations of the study are that it included a small number of patients and it was not shown whether artificial tear drops containing different active ingredients could affect these parameters in the short term.

CONCLUSION

Dry eye occurs in computer users through different mechanisms. Although dry eye tests are not always compatible with the clinic, tear parameters may change in computer users during the short-term working week. In addition, TBUT was found to be the most compatible parameter with the OSDI score, which is an indicator of the subjective complaints of the patient, but studies involving more patients are needed.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Esra Vural;* ***Design:*** *Esra Vural;* ***Control/Supervision:*** *Esra Vural;* ***Data Collection and/or Processing:*** *Esra Vural;* ***Analysis and/or Interpretation:*** *Esra Vural, Leyla Hazar;* ***Literature Review:*** *Esra Vural;* ***Writing the Article:*** *Esra Vural;* ***Critical Review:*** *Leyla Hazar;* ***References and Fundings:*** *Esra Vural;* ***Materials:*** *Esra Vural.*

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