Contact Lens Update
CLINICAL INSIGHTS BASED IN CURRENT RESEARCH

Dry Eye, Blinking and Digital Device Use

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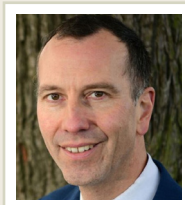

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An unequivocal fact is that pretty much every teenager and adult relies fairly heavily these days on some form of digital device, whether for work or social activities. In fact, surveys of young people in the US show almost all teenagers have a smartphone, frequently use two or more devices at a time and almost half are constantly online.[1, 2] With this, has come increasing reports of dry eye symptoms in those who have extensive use of digital technologies.[3-5] Is it possible that extensive use of digital devices may exacerbate – or indeed even induce – dry eye symptoms?

A systematic review in 2016 identified the prevalence of dry eye disease (DED) in visual display terminal workers to range from 10 % to 88 %.[6] They noted the diagnostic criteria between the 16 studies that met their inclusion criteria were quite variable, including questionnaires on symptoms, tear film anomalies and damage to the cornea and/or conjunctiva, with half of the studies using a combination of criteria. However, the prevalence of dry eye is also very high in the general population, as noted by the Tear Film and Ocular Surface Society (TFOS) Dry Eye Workshop (DEWS II) epidemiology report, where it ranged from 5 to 50 %.[7] Recent studies using the TFOS DEWS II diagnostic criteria[8] of symptomology and signs (tear instability assessed by non-invasive tear breakup time, hyperosmolarity or ocular surface damage assessed by staining) have reported a prevalence rate of 29 to 74 %.[9, 10]

Hence, the high prevalence of dry eye reports in those that use digital screens could simply result from the high levels of DED in the general population. However, a series of recent papers from both our research group[9, 11] and others[12-14] have found digital device use to be a risk factor for DED, particularly during the COVID-19 pandemic.[15-18] There remains an absence of literature exploring digital display-induced ocular symptomology5 or those whose symptoms have been assessed as increasing with the use of digital screens, rather than dry eyes in those that use digital displays, although the condition of digital eye fatigue/syndrome is well described with some symptoms, such as ocular discomfort and eye dryness and tiredness being similar to those of dry eye conditions.[3, 4, 19-21] A recent review by Al-Mohtaseb et al. has examined the relationship between DED and digital screen use, a summary of which, by one of the paper's authors, Bridgitte Shen Lee, is available as the feature article of this issue.

An increased risk of dry eye with digital screen use appears to be associated with evaporative rather than aqueous deficiency DED,[9] and it has long been noted that the blink rate reduces substantially with digital screen use.[5, 22] However, direct comparisons of a reading task of printed hard copy with the same task matched for size, contrast, luminance and viewing angle on a digital screen have found no difference in blink rate.[23, 24] Contrary to this, Benedetto and colleagues examined an e-reader, liquid crystal display (LCD) tablet and printed copy, and while there was a significantly lower blink rate during reading for 1 hour from an LCD tablet device compared to printed text (despite a similar setup, including distance, page size, font size and number of words per page), reading from the e-reader had a similar blink rate to printed text.[25] This suggests luminance and contrast/image

quality may play a key role in blink rate when using digital devices.

Incomplete blinking seems to be a more important driver of symptoms when using digital displays than simply blink rate. [23, 24, 26-29] Blinking is part of the production (expressing the glands), distribution (spreading the tears across the ocular surface) and excretion (by creating alternate positive and negative pressures in the lacrimal sac) of the tear film and hence partial blinking will very likely disrupt the homeostasis of this delicate layer. [30, 31]

The impact of digital device-induced symptoms is less well documented than the effect of DED, although an impact on education, career choice and workplace productivity has been postulated. [3] The change to more on-line schooling due to the COVID-19 pandemic has resulted in high numbers reporting digital device related symptoms (93 %), although symptoms prior to the increase in digital device use was not assessed.[32] Another study found a similar rate of symptoms (96 %) during a COVID-19 increase in computer use (an increase of 4.8 ± 2.8 hours / day), with 57 % reporting an increase in these symptoms since before the pandemic restrictions.[33]

Most concerning is the possibility that increased use of digital displays may cause damage to the meibomian glands, with long term consequences on tear production and symptomology.[34] Abnormal blinking may cause chronic changes in the meibomian glands, altering secretion due to less frequent expression, raising the likelihood of gland blockage, possibly resulting in longer term inflammation and increasing internal pressure causing damage to the internal structures, reducing the outflow of meibum.[35] Hence, it has been proposed that blinking abnormalities, such as reduced blink rate and incomplete eye closure, associated with digital display device use may lead to a high incidence of meibomian gland dysfunction in users. [36] It has been found that people who exhibit incomplete blinking have greater levels of meibomian gland dropout, along with a less optimal tear film lipid layer thickness, tear film stability and meibum quality / expressibility, which predisposed them to the development of evaporative DED.[37] Another study found that greater than 4 hour / day of digital device use was associated with greater lid margin abnormalities, meibomian gland dropout and altered meibum expression.[38] The relevance of this association being applicable to a wide range of patients is illustrated well by the fact that 44% of US children are already using digital devices for more than four hours a day.[39]

Hence, proactive monitoring of the meibomian glands from early in life and more research into their prophylactic management is warranted to prevent a surge in DED affecting the quality of life and productivity of individuals later in life. This is particularly relevant for younger individuals,[40] as teenagers and young children are now extensive users of digital devices, and the chronic, progressive nature of DED may mean that developing dry eyes at an early age could lead to extensive dry eye complications in later life. An example of this is illustrated in Leslie O'Dell's clinical insight in this issue of Contact Lens Update, where she shares her experience of managing a nine-year-old with significant meibomian gland changes.

Take Home Points

1. Digital device use is common among adults and children
2. Hours of use, for work, education, social media and leisure activities are increasing over time
3. It is common for multiple devices to be used over the course of the day and, among young people, concurrently
4. Digital device use is a risk factor for DED
5. Pay attention to incomplete blinks as a main driver of symptoms rather than overall blink rate
6. Be aware of an association between digital device use and alterations in meibomian gland function
7. Assess for, and manage, early meibomian gland changes

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