Meibomian gland dysfunction causing dry eye syndrome in computer users

Abstract

BACKGROUND: Meibomian glands are follicular glands that release lipid that shapes the tear film's superficial layer. A persistent, extensive terminal duct blockage and descriptive alterations in the secretory output indicate meibomian gland dysfunction. Changes in ocular surface integrity characterize digital eye strain, tear film function, blinking patterns, accommodation disorders, differences in fixation, dryness, weariness, and discomfort while using digital gadgets. The COVID 19 pandemic has resulted in almost everything on the digital platform.

OBJECTIVE: To conclude after reviewing various studies (between Jan 2016- Dec 2020) focused on how digital eye strain adversely affects meibomian glands' function and adds to computer users' dry eye symptoms.

STUDY DESIGN: Narrative review article

METHODOLOGY: Various articles were reviewed, published between 2014-2020 in indexed journals. Meibomian gland dysfunction significantly affects blink rate, tear break-up time (TBUT), tear evaporation rate, tear film composition, and corneal staining; we will find its significant effect and relation to digital eye strain.

EXPECTED RESULTS: Based on previous articles.

CONCLUSION: Eyes with meibomian gland dysfunction develop changes such as reduced blink rate, shorter tear breakup time, altered tear film composition, and disturbed ocular surface, which adds to symptoms of the dry eye, especially in chronic computer users.

RESULT: Digital eye strain significantly affects the meibomian gland's function, thus resulting in the altered and poor tear film that finally results in dryness of the eyes.

KEYWORDS: Meibomian gland dysfunction, tear film, Dry eye disease, digital eye strain

Introduction

Meibomian glands are the follicular sweat gland located on the eyelid border and discharge all their contents on the respective local site. They are structurally present on the tarsal plate of both the above and the below eyelids. The three layers in the tear film are the lipid layer, aqueous, and mucus layer. Meibomian glands produce the lipid layer, an essential tear film component. The function of the lipid layer is to prevent water from vaporizing from the eye surface, which is why it is essential to regulate a healthy ocular surface. (1)

Dry eye disease can be stated as "a characteristic ocular surface illness marked by a loss of integrity of ocular surface epithelium and ocular symptoms."The term Meibomian gland dysfunction refers to "Persistent, extensive terminal duct blockage and descriptive alterations in the secretory output." Dry eye can cause changes in the tear film, ocular discomfort, symptomatically evident swelling, and corneal or conjunctival surface epithelium illness. (1) Meibomian gland dysfunction causes imbalanced lipid secretion, which accelerates evaporative tendency of the eye surface and causes tear hyperosmolarity. Individuals with meibomian gland

dysfunction have a faster tear evaporation rate than healthy people. This demonstrates that dry eye disease is linked to the integrity and specificity of the meibum on the ocular surface. (1) Dry eye disease has a documented prevalence of 5% to 50%, whereas Meibomian gland dysfunction has a reported prevalence ranging from 3.5% to nearly 70%. (1) Meibomian gland dysfunction is commonly observed nowadays. (1) Residents of Asia (46.2%–68%) appear to have a higher prevalence of meibomian gland dysfunction than Caucasians (3.6%–30.5%). (1) Recent pathophysiology studies in Japan have given concrete proof about the concept that lipid concentration and oxygen radicals act as a vital function in the onset and continuation of Meibomian gland dysfunction. (2) In individuals with meibomian gland dysfunction, the oily membrane is volatile in the tear film, leading to symptoms like eye irritation, oxidative stress occurring on the corneal epithelium, and sometimes eventually resulting in blindness. Recently, there has been a significant development in technology with the regular and high usage of computers and smartphones. With COVID 19 pandemic, work and education from home have increased time spent on computers, tablets, and mobile phones. These electronic devices have undoubtedly transformed and helped society; nonetheless, they are associated with eye-related issues such as digital eye strain. Digital eye strain can be defined as eye distress and change in vision due to several burdens on the eye, including glint, defocus, adaptation failure, gaze discrepancy, roughness, weariness, and discomfort while operating digital gadgets. (3)

To be precise, the COVID-19 pandemic has significantly altered one's way of living as a result of mostly "social distancing" measures taken to lower SARS-CoV-2 infection rates, prevent susceptible populations, and avert health system collapse. As a result, we've made a few alterations to our everyday routines, such as staring at computer monitors and television screens for more exact tended periods. (4) In fact, spending more time at home is more likely to be associated with spending more time in front of tablets, cell phones, and computer monitors, which leads ophthalmologists all over the world to be concerned about the potential that the myopia is drastically increasing which is known as "quarantine myopia," and digital eye strain. (4) Also, the average duration of using computer monitors and smartphones were found to be significantly associated with asthenopia in the report by Xu.et.al.(4)

Blinking patterns, the role of the tear film, and corneal surface integrity can all be affected using digital devices. These side effects are likely to lead to ocular discomfort symptoms such Itchiness, gritty realism, a foreign body perception, blazing, aching, and inflamed eyes, as well as poor eyesight and clinically diagnosed illness, are all symptoms of dry eye disease. (5) Thus, one can assume a positive association between digital eye strain and meibomian gland dysfunction.

The Rationale of the review article is in context to home confinement during the COVID-19 pandemic; emphasis is put on the significance of not overspending a lot of time staring at computer screens and using handheld digital devices to maintain eye health prevent meibomian gland dysfunction. They are taking breaks between long-duration working on digital devices, especially computers, and educating all possible individuals and communities about the 20-20-20 rule, the must-know topic, and need of the hour. Try to avoid being glued to the computer screen in one's preferred and convenient way. To keep one's meibomian gland properly functioning, one should strictly follow digital well-being and take care of their screen time.

Objectives:

To conclude, after reviewing various studies (between Jan 2016- Dec 2021) focused on how prolonged computer usage can cause meibomian gland dysfunction leading to dry eyes.

Methods

Articles were compiled from papers published in Pubmed, Web of scholars, Scopus between January 2016 to December 2021 using the keywords ‘dry eye disease’, ‘tear film,’ ‘meibomian gland,’ ‘meibomian gland dysfunction,’ and ‘digital eye strain.’ The majority of the public actions were looked upon within the timeline, including original study, meta-analysis, and comprehensive reviews with searches restricted to English. The references of various publications obtained were examined, considering that required articles were also looked upon. Studies based on the individuals who are computer users were considered. The International Workshop on Meibomian gland dysfunction diagnosis subcommittee recommended the following tests in the general clinical setting for the diagnosis of MGD-related disease: Blink rate, tear meniscus height, tear osmolality (if available), tear breakup time, fluorescein staining, Schirmer test, slit-lamp findings (lid changes, meibum expressibility/quality), and meibography. These tests can tell the difference between dry eye and normal eyes, as well as MGD-related evaporative dry eye and aqueous-deficient dry eye. But, no formal clinical criteria for Meibomian gland dysfunction were discovered in that report, which is required for diagnosis standardization. (2)

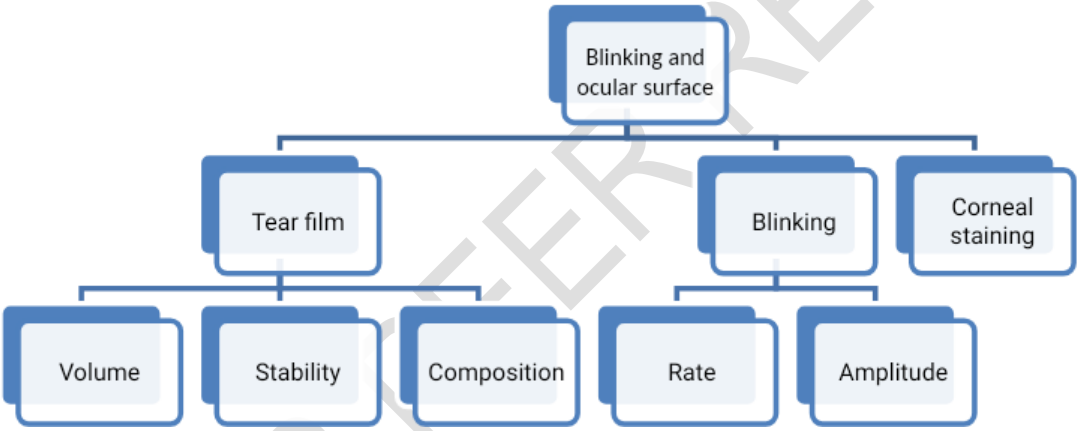

Fig. 1. Flow chart

Variables used in this review article-

1. Blink rate
2. Tear breakup time (TBUT),
3. Tear evaporation rate,
4. Tear film composition
5. Corneal staining

Blink Rate:

The average spontaneous blink rate is approximately around 12-15 times/minute, and usually, one blink lasts about 1/3 seconds. Blinking anomalies can lead to improper tear distribution. As a result, it causes ocular surface damage. (6)

Tear breakup time:

It is a process for finding out the stability of tear film. Sodium fluorescein dye is dropped into the eye, and then ocular film is examined under a slit lamp; simultaneously, an individual resists blinking until a random dry spot appears. The average tear breakup time is approximately around 10-12 seconds. The shorter the tear breakup time, the poorer the tear film, whereas longer tear breakup time results in the better tear film. (7). After installing sodium fluorescein, tear meniscus height can be easily measured, which is used to determine the tear volume.

Tear evaporation rate:
The tear evaporation rate of an average individual is approximately 0.069±0.024 for 25-30% relative humidity and 0.049±0.018 for 35-45% relative humidity (p=0.001). (8)The rate of water evaporation from the tear film is determined under well-defined conditions. A tear evaporimeter is used for measuring water evaporation from the tear film. (9) tear meniscus height is a significant indicator of the tear film volume. In the non obstructed side of the individuals, the tear meniscus height is 0.2mm, while it may rise to 0.6mm on the obstructed side. This shows that the tear evaporation rate may differ with an increase or decrease in tear meniscus height.

Tear film composition:
The tear film comprises the outer lipid, middle aqueous, and inner mucin layers.
The lipid layer slows down the aqueous evaporation and lowers the tear film's surface tension. The function of the aqueous layer is to supply oxygen to the surface of the eye and has a bactericidal effect. The inner mucin layer serves as a lubricant and protects from foreign bodies by converting a hydrophobic surface into a hydrophilic surface. (1)

Corneal staining:
Corneal staining can be used for stain test, which looks at corneal damage. In this test, a colorful dye (usually yellow) highlights areas of damage on the cornea and conditions like dry eye. (10)

Results:
Prolonged use of any digital devices causes digital eye strain. Meibomian gland diseases in computer users alter the tear film functioning, resulting in dryness of the eyes. Handheld digital gadgets and computer monitors may diminish blink rate and tear stability, increasing the risk of dry eye syndrome.

Following is the tabulated interpretation of various studies depicting the effect of meibomian gland dysfunction on Blink rate, Tear breakup time (TBUT), tear evaporation rate, Tear film composition, and Corneal staining.

Table 1. interpretation of various studies

Reference (year)	Purpose	Blink rate	Tear film break up time	Tear evaporation rate	Tear film composition	Corneal staining
3.,(2019)	cause and management of digital eye strain	a.enhanced by audial reminders				
		b.visual prompt of blink instructioncaused increase in blink rate				
		c. anti reflection film can enhance blink rate				
5.,(2019)	ocular and vasclar discomfort associated with computers	lower	Reduced		Lipid layer thickness reduced	
11.,(2021)	Use of digital display and oculor surfar alteration	Reduced				
13.,(2018)	Impact of blinking on ocular surface and tear film parameters	Reduced		Increased	Tear film instability	
16.,(2017)	Visual fatigue induced by beaving a computer with a high resolution display		fluoroscein break up time decreased			
17.,(2020)	Computer display affecting the ocular surface				a.higher osmolarity	
					b.lower tear miniscus height	
18.,(2021)	The influences of computer use on the status of tear film and ocular surface		fluoroscein break up time decreased		a.no change in tear meniscus height	
					b.increased reactive oxygen species	
19.,(2021)	Alteration of tear mucin 5AC in office workers using computer				tear mucin 5AC concetration was reduced	
20.,(2019)	blinking and tear breakup time during four visual tasks					increased corneal staining

Discussion:

Many of the same risk factors that cause dry eye disease also cause meibomian gland dysfunction. As a result, risk factor changes are expected to facilitate both illnesses.

Females are more prone to developing dry eye disease and meibomian gland dysfunction. Androgen and estrogen receptors are located inside the meibomian glands; androgens receptors respond by increasing meibum production while decreasing inflammation, while estrogen decreases meibum secretion while increasing the chances of infections. Patients with androgen deficiency have been found to have dysfunctional meibomian gland secretion and lipid layer changes.

Meibomian gland dysfunction was observed in 60% of individuals who develop dry eye disease; on the other hand, the remaining 20% of the dry eye illness is because of a low amount of aqueous present. (1) The relation of dry eye and meibomian gland dysfunction can be stated on the grounds of oil production, which gets sufficiently reduced in individuals who develop dry eye symptoms at any of their age. While operating computers, it has been observed that the time interval between two blinking is significantly increased, which may be due to the meibomian gland dysfunction. People on computers or any other digital devices tend to blink less, which is reduced by sixty percent when the same participants were not operating computers. This is why oil is not secreted that often when looking at the computer screen. So the composition of tear film will get disturbed. Also, the evaporation rate is increased. This is reflected as an increase in tear break-up time leading to dryness of the eyes. Later, when the situation persists longer, the duct's blockage happens, which results in the development of meibomian gland dysfunction.

Also, the tear film is dispersed evenly over the ocular surface by the movement of the eyelids during a blink. Blinking is vital for maintaining the integrity of the ocular surface, visual clarity, and tear film stability. Insufficient blinking disrupts the balance of tear film replenishment and evaporation, causing tear structure to be disrupted and ocular surface homeostasis to be

disrupted, which, in turn, may result in eye discomfort due to dryness (5). The dryness of the eye leads to several symptoms such as agitation, rough, scratching, or stinging eyes, a sensation of something in their eyes, excessive watering, and dizziness.
Digital eye strain is a bothersome but not life-threatening condition. Various factors such as small text size, reduced contrast, poor visual image, or higher cognitive and visual task strain may develop due to the need for a more extended fixation period. This extension of time required to retrieve visual information has been observed to reduce blink rate. (11) Participants who did not blink enough had more meibomian gland dropout, hence decreased tear film thickness. This decreased thickness of tear film and reduced tear film stability, and expressed meibum quality were the contributory factors for developing the evaporative dry eye. (12,13,14)

An experiment was held in an office, where the participants used to work all the time on the computer screen; their researchers found that computer users had a significantly lower blink rate as the blink rate was lowered by half within minutes of watching the computer in comparison of before they started using the computer. (5,15) Also, increasing attention on computer work may cause increased ocular discomfort due to a slower blink rate. (5)

Tear breakup time: Fluorescein breakup time (FBUT) is significantly reduced after reading an e-book. After a typical day of work, computer users had a shorter tear break-up time than non-users. Computer users who work for more than four hours a day were found to have a shorter tear breakup time than those who used to work for less than four hours a day. In the latter trial, those who worked more than four hours every day had poorer quality meibum expression. (5,16)
Tear osmolarity was more robust and good contributor to dry eye syndromes in computer users than the ocular surface index [17]. A fundamental aspect of meibomian gland dysfunction is abnormal tear osmolarity caused by a breakdown of homeostatic osmolarity regulation. When left untreated, hyperosmolar tears in the initial stage of dry eye, can develop corneal and conjunctival abrasion or damage, which can be seen in later stages of illness. The severity of dry eye disease and digital eye strain is significantly associated with or proportional to the osmolarity. Tear osmolarity was significantly linked to other parameters such as tear breakup time, corneal staining, and, most importantly, meibomian gland dysfunction.[17,18,19] On playing computer games or watching a movie exclusively for three minutes, Himebaugh et al. report a significant increase in corneal staining. In computer workers whose meibomian gland was working perfectly fine, more excellent tear production was observed with longer hours of computer use (20). Choi et al., in their study, discovered that even after continuous use of computer screen for playing a video game, there is no change in the height of tear meniscus, thus reflecting the idea that the tear evaporation rate and tear volume remains unaltered even after long term exposure to computer screen (21). The same study explains the tear composition alteration, which signifies as one of the components of meibomian gland dysfunction, after four hours of computer screen use (21). Doguii et al. compared the vocational computer users exposed for more than six hours per day and controlled individuals who daily use computers for less than one hour. They found that the values of predictors of meibomian gland dysfunction were significantly altered in the form of the height of tear meniscus, which got significantly reduced in computer users, instability of experimental tear film and corneal staining was predominantly increased to a significant value (22). Taste et al. analyzed the association between computer vision syndrome, which is somewhat equal to digital eye syndrome, and contact lens users in computer workers. They concluded that the risk of computer vision syndrome increases

manyfold in those individuals who wear contact lenses and work on a computer screen for six hours or more in a typical day (23-28).

Conclusion: Meimobian gland dysfunction is an important component contributing to dryness of eyes and its symptoms, especially in eyes with digital eye strain. Prevention is the only method for managing the digital eye strain, which includes :

(i) providing an environment or workplace convenient and comfortable environment while working for long hours in front of digital gadgets. This can be achieved by educating patients and implementing standard guidelines of the ergonomic workplace.

(ii) Routine eye check-ups and eye care to address visual abnormalities.

Thus, persons at high risk of acquiring digital eye strain, such as computer professionals or any electronic device users, require special attention to maintaining ocular health.

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