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Meibomian Gland Dysfunction Causing Dry Eye Syndrome in Computer Users

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Review Article

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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. Digital eye strain is characterized by changes in ocular surface integrity, tear film function, blinking patterns, accommodation disorders, differences in fixation, dryness, weariness and discomfort while using digital gadgets. The COVID 19 pandemic have resulted in almost everything to be on digital platform.
Objective: To conclude after reviewing various studies (between Jan 2016- Dec 2020) which were focused on how digital eye strain adversely affects the function of meibomian glands and adds to symptoms of dry eye in computer users.
Study Design: Narrative review article
Methodology: Various articles were reviewed which got published in between 2014-2020 in indexed journals. Meibomian gland dysfunction significantly affects the factors such as blink rate, tear break-up time (TBUT), tear evaporation rate, tear film composition as well as corneal staining, we will find its significant effect and relation to digital eye strain.
Expected Results: Based on previous articles.
Results: Digital eye strain significantly affects the function of meibomian gland, thus results in altered and poor tear film that finally results in dryness of eyes.

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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 on to symptoms of dry eye especially in chronic computer users.

Keywords: Meibomian gland dysfunction; tear film; dry eye disease; digital eye strain.

1. INTRODUCTION

Meibomian glands are the follicular sweat glands that is located on the border of eyelid 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, layer of aqueous as well as mucus layer. Meibomian glands produce the lipid layer, which is an important component of the tear film. The function of lipid layer is to prevent water from vaporising from the eye surface, which is why it is important to regulate 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 "A 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 eye surface and causes tear hyperosmolarity. Individuals having meibomian gland dysfunction are said to have a faster rate of tear evaporation 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 which ranges greatly from 3.5% to nearly 70% [1]. Meibomian gland dysfunction 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 had 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 those having meibomian gland dysfunction, the oily membrane is volatile in the tear film which leads to symptoms like eye irritation, oxidative stress occurring on the corneal epithelium and even sometimes eventually results in blindness. Recently, there has been a significant development in the field of technology with the regular and highly usage of computers and smart phones. With COVID 19 pandemic, work and education from home situation has increased time spent on computers, tablets and mobile phones. All 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 stated as a eye distress as well as change in the vision due to several kinds of burdens on the eye including glint, defocus, adaptation failure, gaze discrepancy, and 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 population and avert health system collapse. As a result, we've made a few alterations to our everyday routine, such as staring at computer monitors and television screens for longer period of time [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, average duration of using computer monitors and smart phones were found to be significantly associated with asthenopia in the report by Xu.et.al [4].

Blinking patterns, role of tear film and corneal surface integrity can all be affected by 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 that there is a positive

association between digital eye strain and meibomian gland dysfunction.

The Rationale of the review article is in context to home confinement during COVID-19 pandemic, emphasis are put on the significance of not overspending a lot of time staring at computer screens and using handheld digital devices in order to maintain eye health to prevent meibomian gland dysfunction. Taking breaks in between long duration working on digital devices, especially, computers. Educating to all possible individuals and community about the 20-20-20 rule which is the must know topic as well as need of hour. Try to avoid being glued to computer screen by one's own preferable 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.

1.1 Objectives

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

2. 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'. Within the timeline, majority of the publications were looked upon including original study, meta-analysis and comprehensive reviews with searches restricted to the English language. 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, that is require for diagnosis standardization [2].

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

2.1 Blink Rate

Normal 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 causes ocular surface damage [6].

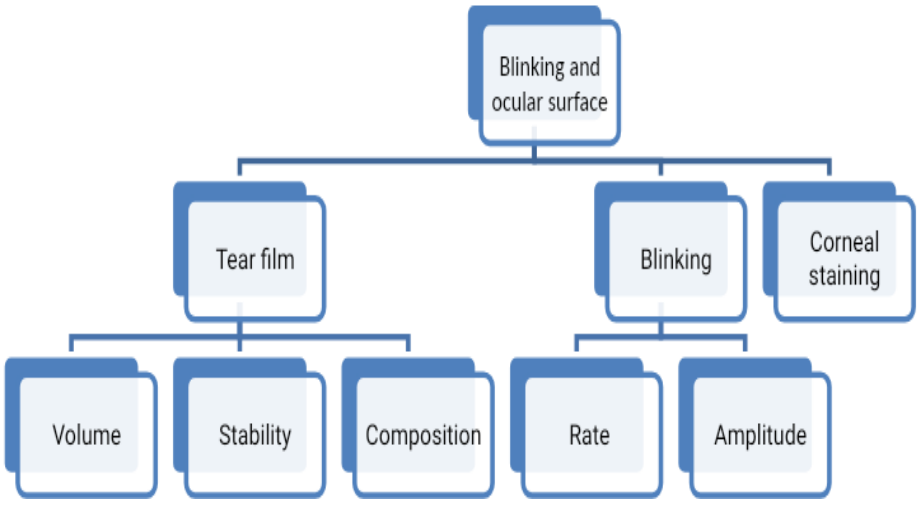

Fig. 1. Flow chart

2.2 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, at the same time individual resists blinking until a random dry spot appears. Normal tear breakup time is approximately around 10-12 seconds. The shorter the tear breakup time, the poorer tear film whereas longer tear breakup time results in the better tear film [7]. After instillation of sodium fluorescein, tear meniscus height can be easily measured which is used to determine the tear volume.

2.3 Tear Evaporation Rate

Tear evaporation rate of a normal 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. 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 non obstructed side of the individuals, the tear meniscus height is 0.2mm, while that in the obstructed side it may raise up to 0.6mm. This shows that tear evaporation rate may differ with increase or decrease in tear meniscus height.

2.4 Tear Film Composition

Tear film is composed of outer lipid layer, middle aqueous layer and inner mucin layer.

Lipid layer slow down the evaporation of the aqueous and lowers the surface tension of the tear film. The function of aqueous layer is to supply oxygen to surface of eye and has bactericidal effect. Inner mucin layer serves as a lubricant and protects from foreign bodies by converting hydrophobic surface into hydrophilic surface [1].

2.5 Corneal Staining

Corneal staining can be use for stain test which is used for looking corneal damage. In this test, a colorful dye (usually yellow) is used to highlight areas of damage on the cornea, as well as conditions like dry eye [10].

3. RESULTS

Prolonged use of any digital devices causes digital eye strain. Meibomian gland diseases in computer user alters the tear film functioning, that finally results in dryness of 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.

4. 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 ameliorate both the illness.

Female is more prone for the development of both dry eye disease and meibomian gland dysfunction development. Androgen and oestrogen receptors are located inside the meibomian glands, androgens receptor response by to increasing the production of meibum while decreasing inflammation, whilst oestrogens decrease meibum secretion while increasing chances of infections. Patients with androgen deficiency have been found to have dysfunctional meibomian gland secretion as well as lipid layer changes.

Meibomian gland dysfunction was observed in 60% cases of individuals who develop dry eye disease; on the other hand remaining 20% of the dry eye illness is because of deficient 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 symptoms of dry eye at any of their age. While operating computers, it has been observed that the time interval between two blinking is significantly increase which may be due to dysfunction of meibomian gland. People while on computers or any other digital devices tend to blink less which is seen reduced by sixty percent when the same participants were not operating computers. This is the reason why oil is not secreted that often when one is looking at the computer screen. So the composition of tear film will get disturb, also evaporation rate is increased. This is reflected as increase in tear break up time leading to dryness of eyes. Later with the passage of time, when the situation persists longer, there is blockage of the duct happens which results in the development of meibomian gland dysfunction.

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 instruction caused increase in blink rate c) anti-reflection film can enhance blink rate				
5, (2019)	Ocular and vascular discomfort associated with computers	Lower	Reduced		Lipid layer thickness reduced	
11, (2021)	Use of digital display and ocular surface 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 viewing a computer with a high resolution display		Fluorescein break up time decreased			
17, (2020)	Computer display affecting the ocular surface				a. higher osmolarity b. lower tear meniscus height	
18, (2021)	The influences of computer use on the status of tear film and ocular surface		Fluorescein 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 computers				Tear mucin 5AC concentration was reduced.	
20, (2019)	Blinking and tear break-up time during four visual tasks					Increased corneal staining

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 integrity of ocular surface, visual clarity and tear film stability. Impaired 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 as well as a

sensation of something in their eyes, excessive watering and dizziness [11].

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 as a result of the need for a longer fixation period. This extension of time that is require to retrieve visual information, have been observed to reduce blink rate [12]. Participants who did not blink enough had more meibomian gland dropout, hence decreased thickness of tear film. This decreased thickness of tear film along with reduced tear film stability and expressed meibum quality, all of them were the contributory factors for the development of evaporative dry eye [13-15].
An experiment was held in an office, where the participants used to work all the time on the computer screen, there researchers found that computer users had a significant lower blink rate as the blink rate was lowered by half within minutes of watching computer in comparison of before they started using computer [5,16]. Also, increasing attention on a computer work may cause increased ocular discomfort due to a slower blink rate [5].

4.1 Tear Breakup Time

Fluorescein break up 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 in a day were found to have a shorter tear breakup time than those who used to work for less than four hours in a day. In latter trial on those who worked more than four hours every day had poorer quality meibum expression [5,17].

Tear osmolarity was determined as a stronger and good contributer of dry eye syndromes in computer users than the ocular surface index [18]. A fundamental aspect of meibomian gland dysfunction is abnormal tear osmolarity, which is caused by a breakdown of homeostatic osmolarity regulation. When left untreated, hyperosmolar tears in initial stage of dry eye, one can develop corneal and conjunctival abrasion or damage, which can be seen in later stages of illness. The severity of dry eye disease and that of digital eye strain is significantly associated or proportional to th osmolarity. Tear osmolarity was significantly linked to other parameters such as tear breakup time, corneal staining and most importantly meibomian gland dysfunction [18-20]. 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, greater tear production was observed with longer hours of computer use [21]. Choi et al., in their study discovered that even after continuous use of computer screen for playing 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 [22]. Same study explains about the tear composition alteration which signifies as one of the component of meibomian gland dysfunction, after four hours use of computer screen [22]. Doguizi et al., compared the vocational computer users who are exposed for more than six hours per day and control individuals who daily uses computer for less than one hour. They have found that the values of predictors of meibomian gland dysfunction got significantly altered in the form of height of tear meniscus which got significantly reduced in computer users, instability of observed tear film and corneal staining was predominantly increased to a significant value [23]. Tauste et al. did an analysis to find the association between computer vision syndrome which is somewhat equal to as digital eye syndrome and contact lens users in computer workers. They concluded that the risk of computer vision syndrome increases many fold in those individuals who wear contact lenses and work on computer screen for six hours or more in a typical day [24-29].

5. CONCLUSION

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

(i) Providing an environment or workplace which is convenient and comfortable while working for long hours in front of digital gadgets. This can be achieved by education of patient and implementation of standard guidelines of ergonomic workplace.
(ii) Routine eye check-up and eye care to address visual abnormalities.

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

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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