ACTA SCIENTIFIC MEDICAL SCIENCES (ISSN: 2582-0931)

Volume 4 Issue 4 April 2020

Review Article

Computer Vision Syndrome: New Age Eye Malady-A Short Review

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Received: January 24, 2020

Published: March 04, 2020

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Abstract

Dry eye syndrome (DES) or keratoconjunctivitis sicca (KCS) is a preventable common disorder of the tear film caused by decreased tear production or increased evaporation and manifests with a wide variety of signs and symptoms. The present review from interpretation of the literature gives detailed information on the prevalence, definition, causes, diagnostic tests, and medical management of dry eye disease. A number of systems contribute to the physiological integrity of the ocular surface and disruption of system may or may not produce symptoms. Therefore accurate diagnosis of dry eyes with no or minimal disruption of physiological function is necessary. The paper also discusses different colloidal drug delivery systems and current challenges in the development of topical ophthalmic drug delivery systems for treatment of KCS. Due to the wide prevalence and number of factors involved, newer, more sensitive diagnostic techniques and novel therapeutic agents have been developed to provide ocular delivery systems with high therapeutic efficacy. The aim of this review is to provide awareness among the patients, health care professionals, and researchers about diagnosis and treatment of KCS and recent developments and future challenges in management of dry eye disease.

Keywords: Dry Eye; Ocular Irritation; Eye Strain Blurred Vsison

Introduction

Dry eye syndrome (DES) is recognized as a common public health problem and one of the most frequent reasons for seeking care. Dry eye is caused by deficiency in quality or quantity of tears, an unstable tear film, ocular surface damage, and bothersome symptoms such as ocular irritation, dryness, fatigue, and fluctuating visual disturbances. Although some risk factors have been identified, the etiology of DES is still largely unknown. It is likely that the ever-increasing demands of modern living that require prolonged visual tasking may play a role in its development [1,2].

As this condition is more frequent in older age projections of greater life expectancy in developing countries will predictably result in an even larger burden of DES on society through direct costs for care and treatment and indirect costs associated with decreased visual function and quality of life. Dry eye syndrome is a common problem that may often be overlooked clinically because it tends not to be a common cause of permanent visual morbidity as traditionally measured [3,4]. Quality of life is a nebulous concept that is hard to define and even harder to measure. There are many approaches to define quality of life the approach of Aaronson view quality of life as a multidimensional construct composed of physical (disease symptoms and treatment), functional (self care, mobility, activity level, and activities of daily living), and psychological/social dimensions (cognitive functioning, emotional status, well being, life satisfaction, and happiness). Researchers rely on a variety

of patient self-reports to serve as quality of life measures. Mass of and Rubin review the development, use, validity, and reliability of all the vision function questionnaires published since 1980 [5].

Dry eye definition and classification

The National Eye Institute/Industry workshop in 1995 defined dry eye as "a disorder of the tear film due to deficiency or excessive tear evaporation which causes damage to the interpalpebral ocular surface and is associated with symptoms of ocular discomfort"[6].

This report divided dry eye primarily in two groups, namely Tear deficient dry eye and Evaporative dry eye

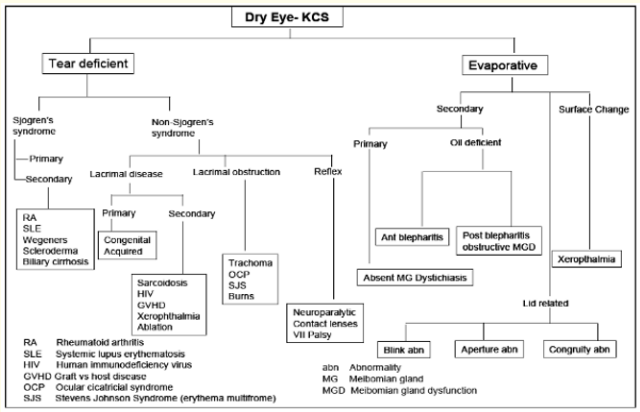

Figure 1

The most recent definition proposed by the International Dry Eye Workshop conducted in 2007 defines dry eye as a "Multifactorial ocular surface disease diagnosed by symptoms of discomfort and signs of visual disturbance, tear film instability and ocular surface damage, accompanied by increased osmolarity of the tear film and ocular surface inflammation [7].

Computer vision syndrome

Definition

American Optometric Association (AOA) has defined Computer Vision Syndrome as a complex of eye and vision associated problems mainly related to activities which stresses the near vision and which are experienced in relation or during the use of computer [8,9].

Blehm., *et al*. 2005 [10] categorized the symptoms in four major categories:

1. Asthenopic- Eye strain, tired eyes, sore eyes
2. Ocular Surface Related- Watering, irritation, dry eye
3. Visual-blurred vision, slowness of focus change, double vision and
4. Extraocular-neck pain, backache, shoulder pain.

Symptoms experienced by the computer users could be brutal enough to cause productivity problems, job dissatisfaction, absenteeism and disability issues. If nothing is done to address the cause of problem, the symptoms will continue to reoccur and perhaps worsen with future computer use [10].

The increased use of computers in the workplace has brought about the development of a number of health concerns. Many individuals who work at a computer report a high level of job- related complaints and symptoms including ocular discomfort, muscular strain and stress. The level of discomfort appears to increase with the amount of computer use. Visual related symptoms occurring in computer users must be recognized as a growing health problems.

Pathophysiology of computer vision syndrome

The eye focusing mechanism in human seems not to be meant for electronically generated characters on the computers, but rather responds well to images that have well defined edges with good background and contrast between the background and the letters.

Therefore, visual work in a computer is demanding and includes frequent saccadic eye movements (ocular motility), accommodation (continuous focusing) and vergence (alignment demands), all of which involve continuous muscular activity [11].

The characters on a computer screen are made of tiny dots called pixels.

Pixels are the result of electronic beam striking the phosphor-coated rear surface of the screen .

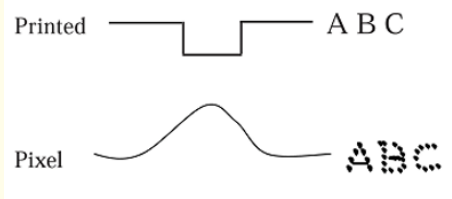

Figure 2

Each pixel is bright at its center and with decreasing brightness towards the outer edges. Therefore, electronic characters have blurred edges as compared to letters on a printed page with sharply defined edges. This makes the human eye very difficult to maintain focus on pixel characters because in an attempt to focus on the plane of the computer the eye fails to sustain the focus, therefore relaxes on to focus behind the screen. This point is referred to as the Resting Point of Accommodation (RPA) or sometimes called the dark focus (Figure 3).

The eyes are therefore, constantly relaxing to RPA and straining to refocus on to the screen thereby leading to eyestrain and fatigue.

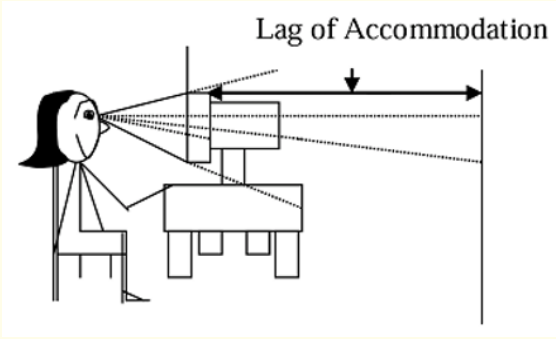

Figure 3

What causes CVS?

There are several contributory factors for Computer Vision Syndrome to develop:

1. Bright Illumination
2. Improper Sitting Posture
3. Dry Eyes
4. Uncorrected Refractive Errors
5. And combination of these factors.

Bright illumination

From large windows, over-head fluorescent tubes, table lamps, and office lighting implements can wash out screen character images and cause annoyance by reflection and glare. Similarly sharp contrast between the illuminated computer screen and hard copy written text leads to asthenopia.

Improper sitting posture

Maintaining a single posture over an extended period of time can cause muscular and ocular problems. Using the wrong chair or just sitting improperly in front of a computer for long time can lead to chronic debilities such as stiffness, headache, and backache. Muscles and tendons can become inflamed due to greater periods of sitting on PC's. Variation in posture while sitting behind the computers can improve the symptoms associated with CVS. Frequent breaks with computer use have been shown to increase comfort and relax the accommodative system [12].

Taking a smaller break for 5 - 10 min more frequently is better than taking a longer break every 2 or 3 hours [13].

A 10 - 15 min break from the computer is recommended for every continuous 1 - 2 hours of computer use [10].

Figure 4: Improper monitor posture.

Dry eye is thought to be the primary cause of ocular fatigue. When working with a computer the blink rate is decreased and the exposed ocular surface area is increased causing desiccation of the eyes. It is thought that the blink rate is further decreased in dark settings where it is difficult to read.

The factors that involved in drying of the ocular surface are:

a) **Environmental factors**: Dry air ventilation fans, static build up, dusty environment, photocopy toner etc.

b) **Reduced blink rate**: Normally people blink 10 -15 times per minute. Studies have shown that the rate is significantly diminished when working at a computer.

c) **Increased exposure**: In normal reading the eyes look downwards causing the lids to cover the part of the cornea minimizing the evaporation of tears. On the contrary the computer operators view it in a horizontal gaze causing wider opening of the palpebral fissure that lead to increased evaporation through exposed area.

The blink rate while working on the computer has been reported to be significantly less than the normal. This leads to poor tear film quality. Mean blink rate went down from 22 per min in relaxed state to 10 per min when reading a book and 7 per min on the VDT.

Uncorrected vision problems

The presence of even minor vision problems can often significantly affect worker comfort and performance at a computer. Uncorrected or under corrected farsightedness, astigmatism and binocular vision (eye coordination and eye focusing) problems can be major contributing factors to computer related eye stress A high percentage of computer operators has been found to have uncorrected or under corrected vision problems that may affect their visual performance and comfort.

Vision problems experienced by computer operators are generally only temporary and will decline after stopping computer work at the end of the day.

However, some workers may experience continued impaired or reduced visual abilities, such as blurred distance vision, even after work.

Prevalance of computer vision syndrome symptoms in computer users

Stella C., *et al.* (2007) did study to assess the visual symptoms complaints among 121 computer users and reported 42.7%, 45.7% and 28.2% of the respondants expierenced eyestrain, blurred vision and headache respectively [14].

Dinesh J., *et al*. (2008) found out prevalence of asthenopia in computer operators. It was noted 46.3% particularly in those who started computer use at an early age, presence of refractive error, level of top of the computer screen with respect to eyes, use of antiglare screen and adjustment of contrast and brightness of monitor screen [15].

Richa talwar., *et al.* (2009) conducted cross sectional study to find out the prevalence of health disorders among computer professionals and its association with working environment conditions. Sample size was 200. Prevalence of visual problems in the study group was 76% (152/200) and musculoskeletal problems were reported by 76.5%. It found gradual increase in visual problems as the number of hours spent for working on computer daily increased [16].

Zairina., *et al.* (2011) reported computer vision syndrome symptoms were reported in 68,1%, predictors for CVS were female, age <27 years old, not taking regular rest and use of computer >7 hours per day [17].

Shrivastava S., *et al.* (2012) conducted cross sectional study of 4 months among software professionals working with private firm. The total sample size for the study was 200. In this study 178 (89%) of the study subjects reported one or more than one computer related health problem. The frequency of computer related problem in the studying group were: redness in eyes 54(40.2%) and pain/stiffness in neck 57 (45.2%) respectively [18].

Mashige KP., *et al.* (2013) did study on ergonomic factors leading to computer vision syndrome 0n 87 participants and found 89% of participants had eyestrain and visual fatigue, headache (81%) neck pain and back ache (77%) were the most severe and frequently reported symptoms, 72% of participants reported taking after 2 hours while 28% reported taking breaks after every hour of computer use. According to this study, the computer workstations were not ergonomically designed and users were not aware that they were not adhering to ergonomic requirements for computer use [19].

Smita Agarwal., *et al.* (2013) did study on factors contributing to the ocular complaints in computer users. High prevalence of eyestrain (53%), headache (42.66%),diminution of vision for distance (34%) among the asthenopic complaints in computer users. Study also revealed prevalence of the visual symptoms was significantly higher in the individuals who spent more than 4 hours daily working on video display terminals [20].

Mekuriaw., *et al.* (2014) conducted study on 284 secretaries and data processors and reported 73.9% of study participants were found to suffer from computer vision syndrome and most experienced symptoms by study participants are blurred vision (31%), eye strain (25%), headache (22.2%), redness(20.1%), watery eyes (19.4%) and dryness of eyes (13.4%). Those who used computers for > 7 hours per day were 2 times more likely to have suffered from CVS as compared to those who spend < 7 hours per day (OR = 2; 95%CI: 1.14 - 3.51) [21].

N Shantakumari., *et al.* (2014) did study on computer use and vision related problems among university students in Ajman, united states. A total 500 students studying in Gulf medical univer-

sity, Ajman and Ajman University of science and technology were recruited into this study. The most common visual problems reported among computer users were headache - 53.3% (251/471), burning sensation in the eyes 54.8% (258/471) and tired eyes 48%(226/471). When the screen was viewed at distance more than 50cm, the prevalence of headache decreased by 38%. Prevalence of tired eyes increased by 89% when screen filters were not used [22].

Lograj M., *et al.* (2014) conducted cross sectional study among the final year medical and engineering (Computer science and Information technology streams) college students of university situated in suburban area of Chennai. A total of 416 final year students were included in the study of which 48.3% (201/416) belonged to medical stream while 51.3% (215/416) belonged to engineering. A total of 334 students reported history of one or more of the symptoms of CVS. The prevalence was found to be 80.3% (334/416). Among engineering the prevalence of CVS was found to be 81.9% (176/215) while among medical students it was found to be 78.6% (158/201). Redness was reported about 13.9% of medical and 23.3% of engineering students. Headache was reported about 43.3% medical and 45% of engineering students. Neck and shoulder pain was reported about 60.7% among medical students and 61.9% among engineering students [23].

Seshadhri., *et al.* (2014) did cross sectional study to find out prevalence of computer vision syndrome among IT professionals working in Chennai. Prevalence of study was found to be 69.3%. The researcher found out the major cause of computer vision syndrome was due to prolonged use of computer without precaution [24].

Manish A., *et al.* (2014) conducted cross sectional study on 134 IT professionals in Nagpur and reported prevalence of health problem in them was 83%, visual symptoms noted in 52% and musculoskeletal symptom noted in 59% [25].

Prevalance of dry eye, convergence insufficiency, and reduced blink rate in computer users

Alireza dehghani., *et al.* (2008) did study on prevalence of ocular symptoms and signs among professional video display computer users (VDU,s)in Isfahan, Iran. Study included 57 (34 males and 23 females) and 56 employees control group (25 males and 31 females) were evaluated. In this study, among VDU's 45 cases (79%) had burning and tearing and 38 cases (66%) had dry eye, 37 cases (65%) had asthenopia and 47 cases (82.5%) had musculoskeletal pain. Schirmer's test was positive in 22 VDU's (38.5%) vs 6 (10.7%) of control group. In this study heterophoria was observed in 19 VDU's (33.3%) vs 3 controls (5.4%), tropia was observed in 10 VDU's (17.5%) vs 6 controls (10.6%) and convergence insufficiency was observed in 17 VDU's (29.8%) vs 10 controls (17.8%) [26].

Miki Uchino., *et al.* (2008) did study on 4393 office workers and reported clinically diagnosed Dry eye disease was present in 266 (10.1%) of 2640 male subjects and in 195 of 909 female subjects. More than 4 hours of VDT use was associated with an increased risk of DED (odd ratio [OR], 1.68; Confidence interval: 1.40 - 2.02 [27].

Gauri Shankar Shrestha., *et al.* (2010) did study on visual problems among video display terminal (VDT) users in Nepal. Ocular changes were reported in 92.1% of the total subjects. The common change was accommodative infacility. The most common symptoms were tired eye and headache, convergence insufficiency was noted, reduced tear secretion was indicated by schirmer's test II was found to have a little role in manifesting the symptoms. In total 76 subjects, 53 males (69.7%) and 23 subjects(30.3%) were female. Distance and near exophoria was found in 10 subjects (13.2%) and 12 subjects (15.8%) respectively. Accommodative infacility (35.5%) was the most common abnormality diagnosed followed by fusional insufficiency (14.8%) and lag of accommodation (13.6%) [28].

Husan Amalia., *et al.* (2010) did study on accommodative insufficiency as cause of asthenopia in computer using students. The study included 99 students from Faculty of computer science, university of Indonesia. The prevalence of asthenopia in this study was 69 (69.7%) while that of normal subjects was 30 (30.3%). Refractive asthenopia was found in 95.7% of all asthenopia patients with accommodative insufficiency constituting the most frequent cause at 50.7%. Convergence insufficiency was found in 4.3% of the asthenopia group. The refractive errors most frequently encountered in this study were myopia (21.7%), astigmatism (2.9%) and compound myopic astigmatism (4.3% [29].

Portello., *et al.* (2013) did study to determine blink rate in computer users. The subjects were required to perform a continuous

15 minute reading task on the desktop computer at a viewing distance of 50 cm. Subjects were videotaped during the task to determine their blink rate and amplitude. The mean blink rate during the task was 11 blinks per minute. The findings of the study confirmed that increased symptoms during computer operation are associated with both reduced blink rate and an increased percentage of incomplete blinks [30].

Mohamed Yehia., *et al.* (2013) did study on probable effects of exposure to electromagnetic waves radiated from video display terminals on some visual functions. It was cross sectional study that included good matched control personnel. The clinical assessment included 1) Visual acuity 2) Refraction 3) measurement of ocular dryness using: Schirmer test, Fluroscein staining, Rose Bengal staining, TBUT. It included 150 computer professionals; and another 150 control group. In this study occurrence of headache in exposed (102/150) 68% vs (0) in control group; tired eyes in exposed(138/150) 92% vs (27/150) 18% in control group; burning tearing eyes(76/150) 50.67% vs (24/150) 16% in control group; blurred near vision (62/150) 41.33% vs (24/150) 16% control group were observed. Occurrence of dryness was 37.33% in cases vs control group 21.33% [31].

Sanjeev kumar., *et al.* (2013) did impression cytology in computer users and control group. Conjunctival impression cytology results in control group were of stage 0 and stage I, while in computer user group showed results between stage II to stage IV. Among the computer users, the majority (> 90%) showed stage III and stage IVchanges. Those who used computers daily for long hours developed more CIC changes than those who worked at the computer for a shorter daily duration [32].

Rahul Bhargava., *et al.* (2014) found out diagnostic value and accuracy of conjunctival impression cytology, dry eye symptomatology and routine function tests in computer users. A case control study was done. Dry eye questionnaire (DESS) was administered to both groups and they further underwent measurement of TBUT, Schirmer's and CIC. TBUT, Schirmer's test values and Conjunctival impression cytology were abnormal in 48.5%, 29.1% and 38.4% symptomatic computer users respectively as compared to 8%, 6.7% and 7.3% symptomatic controls respectively. DESS should be used in combination with TBUT and CIC for dry eye evaluation in computer users [33].

Review on knowledge, attitude and practice regarding computer vision syndrome

Indian journal of ophthalmology (2007) conducted a study on knowledge, attitude and practices towards computer vision syndrome prevalent in Indian ophthalmologist and to assess whether computer use by practitioner had any bearing on knowledge and practice in computer vision syndrome. Results were all doctors were aware of computer vision syndrome. The chief presenting symptom was eye strain, headache tiredness, burning sensation, watering and redness. Also reported focusing from distance to near and vice versa, blurred vision at distance, blepharospasm form part of syndrome. Main mode of treatment was tear substitution [34].

T.R. Akinbinu., *et al.* (2013) did study on computer vision syndrome among computer users in the workplace in Abuja, Nigeria. 40% of participants were aware of CVS of which 27% had knowledge of the disorder. The study concluded that there is serious knowledge gap about the CVS in the studied population [35].

Huda Zainuddin., *et al.* (2014) did study on effect of human and technology interaction- computer vision syndrome among administrative staff in a public university found, out of 146 respondents, a total of 92 (63%) respondents had computer vision syndrome. 35.6% had poor level of knowledge, while 50% had poor attitude on visual ergonomics [36].

Amirul FZ., *et al.* (2015) did study on video display terminals users 172 subjects reported 88/172 respondents had good knowledge about CVS while 88 (48.8%) had poor knowledge and 90 (52.3%) of the respondents had good level of attitude on CVS while 82 (47.7%) respondents had poor attitude. (80.2%) had good level of practice [37].

Association of computer vision syndrome and gender

Many studies have reported a significant association between female gender and prevalence of CVS.

A. Subbratty., *et al.* (2005)The main findings from the present study have highlighted eye problems, lower back pain, and severity of pain increased with number of hours of computer use as well as length of employment in the respective job. Report of symptoms of OOS was higher among female participants (58%) [38].

Z.A. Rahman., *et al.* (2011) In a study of demographic and Computer Related Factors Gender was significantly associated with CVS and univariate analysis showed that female had 2.69 (95%CI: 1.78, 4.07) higher odds for CVS compared to male respondents. Logistic regression analysis strengthens this finding and revealed that gender was a significant predictor for CVS when other factors in the model were constant with odds of 2.3 (95% CI: 1.45, 3.65) [39].

J.K. Portello., *et al.* (2012) in a study observed that symptoms varied significantly with gender (being greater in females), ethnicity (being greater in Hispanics) and the use of rewetting drops. A significant positive correlation was observed between computer-related visual symptoms and the Ocular Surface Disease Index (OSDI), a measure of dry eye [40].

Logaraj., *et al.* (2014) in a study however reported redness, burning sensation, blurred vision and dry eyes were comparatively more in males than in females [23].

Vision related quality of life

Sullivan Rm., *et al.* (2002) and Nichols KK., *et al.* (2002) found out the dry eye syndrome did had an effect on quality of life measures. Nichols and associates used the National Eye Institute Visual Function Questionnaire-25, a generic vision-related quality of life tool designed to measure the impact of ocular disorders such as glaucoma, cataract, and age-related macular degeneration to study vision-related quality of life among predominantly mild to moderate DES patients, particularly in relation to reported ocular pain [41,42].

Rajagopalan K., *et al.* (2002) have observed statistically significant differences in both the generic SF-36 quality of life scale as well as a DES-specific quality of life instrument, the Impact of Dry Eye on Everyday Life questionnaire, across varying levels of DES severity. People with DES blink twice as often as normal controls under relaxed conditions [43].

Hayes JR., *et al.* (2007) in a study that was designed to look at the relationship between eye symptoms and quality of life in a workforce of computer users reported number of hours directly working at the computer was not the major factor impacting quality of life. After controlling for job quality and other factors eye symptoms had a very small but statistically significant relationship with a global measure of quality of life. There was a very large association between eye and physical symptoms. We did not find significant relief from physical symptoms with occupational lenses among the small number of wearers in the sample but did show that lighting was associated with symptoms for some workers. Further research may find that methods addressing eye issues may impact overall physical comfort in the workplace [44].

Miljanovic B., *et al.* (2007) in a study to evaluate the impact of dry eye syndrome (DES) on vision-associated quality of life it was found that DES is associated with a measurable adverse impact on several common and important tasks of daily living [45].

Mertzanis P., *et al.* (2005) in a study to assess the relative burden of dry eye in daily life, results indicate dry eye's negative impact on everyday life, particularly in daily activities [4].

Conclusion

The overarching complexity of the dry eye disease makes it challenging to diagnose and manage accurately. With development of objective tests with precise diagnostic value and minimal disruption of physiological function, accurate diagnosis of disease is possible. Recent knowledge about causes, symptoms, and diagnostic tests of KCS provides better opportunities for improving medical management. Development of new potential drugs and different colloidal delivery systems definitely provides a ray of hope for more effective treatment of this widely prevalent and debilitating disease.

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