# Computer vision syndrome

**Saman Wimalasundera**
*Senior Lecturer in Community Medicine and Ophthalmologist, Community Ophthalmology Centre, Faculty of Medicine, University of Ruhuna, Galle.*

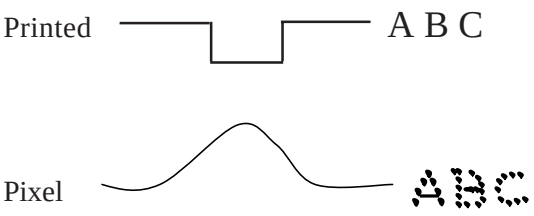
The computer has become a part of the everyday life at present. Even in Sri Lanka a considerable percentage of the work force uses computer for their job. In the world it has been estimated that nearly 60 million people experience vision problems as a result of computer use. This computer related ocular condition is called Computer Vision Syndrome (CVS). Millions of new cases occur each year.

Some decades back, before the advent of computers, the office work involved a range of activities, including typing, filing, reading and writing etc. All these activities are different from each other and needed different types of posture and vision, causing a natural break from each activity. With the computer all these activities were combined and needed no change of posture or vision of the user from his desktop. It certainly improved the quality of the work and efficiency but caused ocular problems, such as dry eye, redness, irritation, eye strain, tired eyes, temporary blurred vision, light sensitivity and muscular problems that stem from using a computer. All these symptoms collectively referred to as computer vision syndrome, which comprised of ocular surface abnormalities or accommodative spasms and/or extra-ocular (ergonomic) aetiologies due to improper posture such as neck and upper back pain and headache.

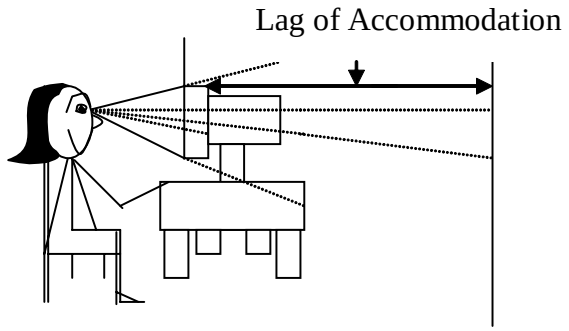
The major contributors to CVS is thought to be the dry eye, the visual effects of video display terminals (VDT) such as lighting, glare, display quality, refresh rates and radiation and positioning of computer monitors.

**Visual mechanisms on VDT screen**

The focusing systems of human eyes are not meant for electronically generated characters on the VDT. It responds perfectly to the images that have well defined edges with good background contrast. (eg: solid black letters on white background). VDT letters are made up of small dots or pixels. Each pixel is bright at its center and with decreasing brightness towards its outer edge.




The human eyes find it very difficult to focus on the pixel characters. The eyes focus on the plane of the computer screen but cannot sustain that focus. Then it will relax on to a focus behind the screen. This point is called the resting point of accommodation (RPA) or dark focus. RPA is different from person to person but it is somewhat away than the normal working distance to the computer. Therefore the eyes are constantly relaxing to RPA and straining to refocus on to the screen constantly.




The constant changing of focusing by the ciliary body creates fatigue to the eye and causes accommodative symptoms pertaining to CVS.

**Studies on CVS**

By the year 1992, a total 1307 surveys were completed by American optometrists and reported that the majority of VDT patients have symptoms that are different from other near point workers in relation to glare, lighting viewing conditions and spectacle requirements. Travers and Stanton identified a trend in symptomatology. They reported that the symptoms appeared to increase as the duration of VDT exposure increases. It has been estimated in the USA that the diagnosis and treatment of CVS costs about $ 2 billion each year.

**Computer vision syndrome and children**

Children have more access to computers either at home or at schools now. Parents also encourage children at very early years to use the computers. It is believed that heavy computer use among children put them at the risk of getting early myopia. Several studies have shown it.

- 25% - 30% of computer using children need corrective glasses - A study at the University of California at Bekerly School of Optometry.
- The percentage of patients who work with myopia has increased from 12.1% to 20.4% since 1995 according to a study by the department of health in Taiwan.

According to American Optometric Association the impact of computer use on children is vision involves three factors.

1. Children have a limited degree of self-awareness. They perform a task on computer for hours and hours without breaks. This prolonged activity causes CVS.
2. Children are very adaptable. They assume that what they see and how they see is normal, even if the vision is problematic. Therefore parents need to monitor their work.
3. As children are smaller than adults the computer work station set up arranged for adult usage does not suit the requirement of children. Computer users should view the screen slightly downwards at a 15° angle.

**Symptomatology**

As described earlier symptoms can be categorized as,

1. Accommodative or asthenopic symptoms
2. Ocular surface related symptoms
3. Extra ocular symptoms

The table shows relevant symptoms and diagnosis

*Table 1 - Computer related ocular symptoms and diagnosis*

| Symptom category | Symptoms | Diagnosis |
|---|---|---|
| Asthenopic | Eye strain<br>Tired eyes<br>Sore eyes<br>Dry eyes | Binocular vision<br>Accommodation |
| Ocular surface related | Watery eyes<br>Irritation<br>Contact lens problems | |
| Visual problems | Blurred vision<br>Poor focusing change<br>Double vision<br>Presbyopia | Refractive error<br>Accommodation<br>Binocular vision |
| Extra ocular | Neck pain<br>Back pain<br>Shoulder pain | Presbyopic correction<br>Computer location |

Some patients have marginal vision disorders such as difficulties in accommodation or binocular visual problem that do not cause problems when performing less demanding visual tasks. Prolonged VDT usage causes diminished power of accommodation and removal of the near point of convergence causing deviation of the eye for near vision. These symptoms are most likely transient with workers returning to their baseline accommodative values by the end of the day or week. Too much of accommodative efforts may be a causative factor in the development of myopia. Luberto et al observed a transient myopia in 20% of VDT workers at the end of their work shift. It is still questionable whether VDTs are associated with a risk of myopia progression in adults compared to paperwork.

Dry eye is thought to be the primary cause of ocular fatigue. When working with a VDT 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;

1. Environmental factors – dry air ventilation fans, static build up, dusty environment, photocopy toner etc.
2. 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.
3. 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.
4. Sex – It is found that the prevalence of dry eye is slightly higher among females.

5. Age – Tear production normally decreases with age. Post-menopausal women are the group of individuals who are mostly affected.
6. Systemic diseases and medications - Dry eye is associated with some systemic diseases. (eg: Sjogren syndrome, rheumatoid arthritis, and several auto immune diseases.) Treatment diuretics, antihistamines psychotropic and some antihypertensives are associated with dry eyes, and patient taking such treatment are more prone to get CVS.
7. Contact lens use - Office workers wearing contact lenses are more likely to suffer due to CVS. Contact lens comfort is highly dependent on lubrication of the eye.
8. Other ocular pathology - Dysfunctions of the lid glands as in blepharitis affecting Meibomian glands causes lack of adequate lipid layer in tears that causes more evaporation.

**Visual effects due to computer screen display**

Visual effects are due to number of display characteristics such as character size structure, style and the image contrast and stability.

***Display quality***

As discussed earlier images are produces mainly by pixels and raster (horizontal lines). The images formed by them lack sharp edges. Slightly blurred characters create an under stimulation of accommodation and causes lag of accommodation behind the screen. Resolutions of the monitors are associated with visual fatigue. Resolution of monitors has improved drastically over the past decade.

***Lighting and glare***

Bad lighting conditions of the surrounding area of the computer can adversely affect the eyes of the user. Bright illumination from surrounding (head fluorescents, large windows, desk lamps) can wash out screen character images. It creates a glare and reflection. It causes annoyance and visual fatigue. It has been shown that surrounding luminance significantly reduces accommodation amplitude. Glare causes delay in reading time and when it is not possible to change the surrounding lighting system anti-glare filters are used to reduce it. But some studies (a study with 25, 064 participants) investigated for incidence of asthenopia did not show that the filters reduce the occurrence of asthenopia.

***Refresh rates***

Refresh rate is the number of times per minute the screens repainted to produce an image (measured in Hz). If the rate is too slow characters will start to flicker. It causes annoyance fatigue and headache. The critical fusion frequency (CFF) is the refresh rate that human eyes do not distinguish the pulsating beams flicker as separate entities. It is 30-50 Hz. Therefore it is recommended to have 75Hz that removes flicker at all brightness levels. Studies have shown that much higher refresh rates decreases ocular symptoms and improves the reading rate too. Liquid crystal displays (LCD) have very high refresh rates compared to cathode ray tube (CRT). LCD is an advance in screen technology that minimizes ocular discomfort.

***Radiation***

It was earlier thought that the radiation emission from VDT causes health effects to the user. Ionizing radiation is known to cause human cellular changes and break down the chemical bonding and change the neutral molecules. But VDTs do not produce or emit alpha, beta or gamma rays or hard x-radiation. Small amounts of soft x-rays are produced. But it is also contained by the monitors' glass screen. Studies have shown that there is no evidence to support that VDT operators face hazards like skin cancers, spontaneous abortions and ocular abnormalities due to ionizing radiation. Research should be done to define the risk of electromagnetic radiation produced by VDT.

**Prevention and treatment of CVS**

It is multidirectional because different people have different complaints. Treatment needs ocular therapy as well as workplace adjustments.

***Lighting***

Light should not be too bright and set in a way that it does not throw bright light in to the eyes or on to the computer screen producing glare Excessive fluorescent lighting should be reduced and window lighting should be filtered with curtains or blinds or tinting. Anti-glare filters may not reduce the symptoms of asthenopia but provide visual comfort.

### *VDT positioning*

Postural difficulties at the VDT lead to pain in the back neck and shoulders. It is important to keep the monitor at a proper distance and height. Studies have shown that improvement of physical ergonomics reduces discomfort at computer stations and improves performance.

It is recommended that the eye should be 35-40 inches away from the monitor. (Earlier it was thought to be 16-30 inches but it has been proved now that at shorter distances people get more eyestrain).

It is also recommended that the screen should be placed 10-20 degrees below the eye level. When the screen is higher than this, the user turns the head back and causes muscle strain on the trapezius and neck muscles. When the monitor is lower, the gaze is downwards and exposes less ocular surface reducing tear filters evaporation. Studies have shown that raised monitor has no beneficial effect on postural stress of the cervical spine.

### *Work breaks*

When regular breaks are given work efficiency improves. This has been proved by studies. Short frequent breaks are recommended. A quick walk at the break (around the office) will give a stretching to the fatigued muscles. It provides the change of focus of the eye and relaxation. It is believed that looking away at a distance at least twice an hour is sufficient for prevention of visual fatigue.

### *Lubricating eye drops*

Symptoms caused by dry eyes can be relieved by lubricating drops. Over-the-counter tear substitutes are available at pharmacies. It can be used periodically to rewet the ocular surface. It helps in maintaining the balance of salts and acidity too, while working with the computer. It is important to find the proper lubricating drop for the computer user. Higher viscosity of lubricants reduces the visual acuity.

### *Computer spectacles*

An occasional computer user may be able to use his own spectacle and use the computer without much problem. But those who spend more than 1 – 2 hours per day can benefit from computer glasses. Progressive lenses are thought to be better but still the users will find a "perfect-spot" with the lens and use only that spot for viewing the monitor. This also resulting annoyance and head/neck strain. Occupational progressive lenses are now designed to have a large area on the top half of the lens for mid distance viewing (arms length viewing) and a bottom half for near viewing (for the key board). Presbyopes need special attention when deciding on the right glass for the computer. A micro environment glass (MEGS) is presently under study which will address the ocular surface pathology also. Removal of accumulation of airborne particles and irritants are expected to include in this design.

## References


1. Abelson MB. How to fight computer vision syndrome. *Reviews of Ophthalmology* 1999; 114-6.
2. Sheedy JE. Presbyopia and computer users. *Refract Eye Care Ophthalmology* 1999; **3**: 5-9.
3. Berqvist UO, Knave BG. Eye discomfort and work with visual display terminals *Scandinavian Journal of Work Environment Health* 1994; **20**: 27-33.
4. Carter JB. Banister EW. Musculo skeletal problems in VDT work: a review. E*rgonomics* 1994; **37**: 1623-48.
5. Cheu RA. Good vision at work. *Occular Health Safety* 1998; **67**: 20-4.
6. Campbell FW, Durden K. The visual display terminal issues, a consideration of its physiological, psychological and clinical background, *Ophthalmic Physiology* 1994; **3**: 1623- 48.
7. Berm M. et al An occupational study of employees with VDT associated symptoms – The importance of stress *Medicine* 1996; **12**: 51-4.
8. Bachman WC. Computer specific spectacle lens design preference of presbyopic operators. *Journal of Occupational Medicine* 1992; **34**: 1023-7.
9. Berman SM Greenhouse DS Bailey IL, et al. Human electroretinogram responses to video displays, Fluorescents lighting and other high frequency sources. *Optometry Visual Science* 1991; **68**: 645-62.
10. Acosta MC, Galler J, Belmoute C. The influence of eye solutions on blinking and ocular comfort at rest and during work at video display terminals. *Experimental Eye Research* 1999; **68**: 663-9.
11. Bauer W, Witting T. Influence of screen and copy holder positions on head posture, muscle activity and user judgment. *Applied Ergon*omics 1998; **29**: 185-92.