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Evaluation of Various Factors Responsible For Eye Strain in Video Display Terminal Users

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Abstract **Original Research Article**

Computer usage is increasing day by day and using one can be quite demanding on the eyes. Constant eye movements including continuous focusing and aligning, the problem of the computer screen that flickers and can cause glare, all lead to eye strain. Computer users also tend to blink less when looking at a video screen, leading to dry eyes. We conducted a study on 100 subjects working on computers for a period of 4 hours or more daily. A detailed anterior segment examination was supplemented by refraction workup, measurement of NPA and NPC, Schirmer's test and tear film breakup time. Symptoms were suggestive of ciliary body strain and ocular surface dryness. Long hours of near vision focusing seem to be causing asthenopic symptoms. Low blink rate and air conditioning dryness were etiological for the ocular surface dryness.

Keywords: Eye, Computer, Video Display.

INTRODUCTION

The advent of computers has had a major impact on many aspects of our lives. Most people now have some contact with computers at work and computers are being used increasingly for education and leisure. The introduction of computers has led to dramatic changes in work practices for many people. For example 20 years ago an office job typically involved a range of activities including reading, writing, typing, feeling etc. switching between activities introduced a short natural break and the activities themselves were sufficiently varied to require a change in posture and provided some variation in the nature of mental and visual activity. Today, many of these activities can be carried out without moving from a computer [1]. This change in work practices has been accompanied by increase in complaints about a number of health problems associated with working of video display terminal (VDTs). Of these, eye problems are single most common complaints [2].

Video display unit (VDU) workers report a wide range of subjective complaints of visual fatigue and somatic disorders [3-5]. General symptoms reported are backache, neck pain, mental fatigue, shoulder or neck stiffness, pain in arms or hands, general fatigue not relieved by rest [5]. The main visual symptoms reported by VDT users are tired eyes, eye strain, and irritation, burning sensation, redness of eyes, blurred vision and double vision [6-9].

Over past decade there have been major advances in display technology. Various forms of flat panels are being used increasingly as an alternative to conventional cathode ray tube (CRT) monitors. However such displays still account for a small proportion of market. In general, the contrast of characters displayed on a VDT screen is less than printed text. According to Miyao *et al*. it is easier to read dark letter on a light background (positive contrast) rather than vice versa (negative contrast) [10].

Work station design include viewing angle, viewing distance, lightning condition etc. if viewing angle is not proper this tends to lead a number of problems in VDT users like dry eyes [11-14]. VDT is generally viewed from slightly further away than printed matter which can cause problem for older operators. A common cause of eye problems among VDT users is inappropriate lighting. A high proportion of VDT related eye problems are caused by poor work station design and inappropriate lighting [15-18]. The optimum lighting condition for reading printed text and viewing a VDT are quite different but often the two tasks are carried out in the same location and more or less simultaneously. This means that there must be a

compromise and it is generally accepted that a horizontal luminance of 300-500 lux is a reasonable balance. 1Inappropriate lighting design can also lead to problems of glare. As a general rule, the immediate surround to the screen should be approximately matched to the mean luminance to the screen. Where it is impractical to reduce ambient light levels, some improvement in screen contrast can be achieved by placing a glare filter in front of the screen [19-21].

Working at a VDT involves sustained accommodation and vergence and most tasks involve a high degree of cognitive efforts. Poor work station design, inadequate provision for breaks and a stressful environment often compound the problem and leads to complaints by individuals who are normally asymptomatic. Likewise small refractive errors and oculomotor problems may only cause symptoms under the more demanding conditions associated with sustained VDT work [8, 22, 23].

In past efforts to identify the mechanism underlying visual fatigue related to VDU work, authors have concentrated on standard optometric tests (e.g. refractive error, later phoria, contrast sensitivity) under induced controlled experimental workload. The tests were usually performed before and after 1-2 hours of continuous computer work and results were compared. Some studies reported no consistent effect of VDU work on these variables whereas others reported consistent effects [24-26]. Experimentally, two variables accommodation and convergence appeared to be linked most often with VDU work [27].

Complaints of ocular fatigue among users of VDTs have increased along with the presence of this technology in the modern work place. Dry eye is now believed to be a major source of this problem. Since VDT users tend to have a wide palpebral fissure and hence greater exposed ocular surface area as well as a lower blink rate. Increased tear evaporation is the primary determinant of tear dynamics in this case. Possible explanation for decreased blink rate includes concentration on the task or a relatively limited range of eye movements. Consequently, the tear film gets replenished less frequently and evaporates more quickly, causing ocular discomfort [28, 29].

Computers and VDUs have become indispensable to many workers, and concern has been increasing steadily regarding the effects of prolonged visual work at near distance. VDU workers report a wide range of subjective visual complaints like eye strain, ocular pain, blurred vision, irritation, burning sensation, headache, double vision and general symptoms like headache, back pain, shoulder or neck pain, mental fatigue, general fatigue not relieved by rest [2-5].

The rising use of VDTs has significant touched the problems of the dry eye. From the view of variable literature it reveals that this study has not been conducted in this part of country and the informatory data for same is not available. A prospective study starting with grass root level may check the ever growing eye problems with use of VDT. Therefore, the present study has been planned with the specific aims and objectives.

MATERIALS AND METHODS

The study was carried out on 100 cases of either sex in age group of 15 to 25 years. The students were approached at the computer centre before the start of academic session. Only those were included in the study that had either never worked on the computer in the past or had been working occasionally. Subsequently only those cases formed a part of study that had to worked on computers daily for 4 hours or more.

Subjects having pre-existing phorias, convergence insufficiency, history of any ocular surgery, any chronic infection in eye, pre-existing corneal surface disorder and history of prolonged use of contact lenses were excluded from study.

The subjects were enquired about eye strain, sensation of tension in and around globes, headache, eye ache, itching, burning, sourness of eyes, foreign body sensation in eyes, dry eye sensation, blurred near vision, double vision and crowding of words while doing near work, during each visit.

After recording the symptoms complete ophthalmological examination like visual acuity, refraction, fundus examination, tests for binocularity of vision, Maddox rod test, NPC, NPA and adduction/abduction on synoptophore were carried out. Tear film break up time and Schirmer's test were done in all the cases.

Follow up of all the cases were carried out after 3 months and 6 months. The t-test was used for analysis of continuous data (including paired t t-test for comparison of sequential timed data).

RESULTS

The present study included 100 cases that were approached at the computer centre before the start of academic session. Only those cases formed a part of study that had to work on computers daily for 4 hours or more. They were called to Department of Ophthalmology, Pt. B. D. Sharma Postgraduate Institute of Medical Sciences, Rohtak for complete ophthalmological examination.

The following observations were made

Age distribution

All the subjects were in the age group of 15 to25 years. Mean age was 19.70±1.79 years. (Table 1).

Sex distribution

There were 71 male and 29 female subjects with sex ratio 2.4:1.

Prevalence of asthenopia

Among 100 subjects, 10 subjects developed asthenopic symptoms after 3 months of VDU use while 42 subjects had asthenopia after 6 months of VDU use (Table 2).

Table-1: Sex distribution

Age groups (years)	No. of subjects	Mean ± SD
15-20	65	18.6±1.01
20-25	35	21.6±0.05
Total	100	19.7±1.79

Table-2: Prevalence of asthenopia

	0 month	3 months	6 months
Asthenopia present	0(0%)	10(10%)	42(42%)
Asthenopia absent	100(100%)	90(90%)	58(58%)

Modification of refractive status

The modification of refractive status was considered separately in emmetropic, hypermetropic and myopic subjects.(Table 3) Refractive modification of all groups were not statistically significant (p>0.05).

Table-3: Modification of refractive status

Refractive states	VDU use (n=100)		
	0 months	3 months	6 months
Emmetropia	80	80	75
Myopia	16	16	20
Hypermetropia	4	4	5

Prevalence of convergence insufficiency

Convergence insufficiency was diagnosed on the basis of remoteness of near point of convergence (NPC) beyond 9.5cm and poor fusional amplitude on synoptophore i.e. less than 30 degree. The difference in NPC, Adduction range and NPA was statistically significant (p<0.001) (Table 4).

Table-4: Prevalence of convergence insufficiency

	Mean ± SD			'p' value
	0 month	3 months	6 months	
NPC (cm)	7.32±0.75	7.89±1.36	8.11±1.40	<0.0001
Adduction (°)	32.00±1.42	27.55±5.73	25.08±5.96	<0.001
NPA (cm)	8.565±0.49	8.71±0.64	8.94±0.74	<0.001

Prevalence of dry eye

After 3 months of VDU use only 3 subjects had Tear film break up time less than 10 seconds and Schirmer's test less than 10 mm while after 6 months 11 subjects had tear film break up time less than 10 seconds and Schirmer's test less than10 mm. (Table 5)

Table-5 Prevalence of dry eye

	No. of subjects		
	0 month	3 months	6 months
Dry eyes	0	3 (3%)	14 (14%)

DISCUSSION

Most people now have some contact with computers at work or at home. With survey evidence suggesting that perhaps 50% or more of these individuals complain some form of eye problems associated with using computers, eye care professionals, ergonomist and engineers and faced with a major challenge.

We conducted a study on 100 subjects of either sex in age group of 15 to 25 years. The students were approached at computer center at the start of academic

session. Only those individuals were included in the study who had either never worked on computer in past or had been working occasionally. Only those cases formed part of study that had to work on computers daily for 4 hours or more. They were called to Department of Ophthalmology, Pt. B.D. Sharma Postgraduate Institute of Medical Sciences, Rohtak. They were examined at the start of session, after 3 and 6 months of video display unit (VDU) use. During each visit they were asked to answer questionnaire about working condition and after recording the asthenopic symptoms complete ophthalmological examination was done.

The mean age in years was 18.6±1.01 and 21±0.05 in age groups of 15-20 years and 20-25 years respectively. Overall mean age of subjects was 19.7±1.79 years. The sex ratio was 2.4:1. In our study 91% subjects were working in bright illumination. Only 65% subjects had air-cooling system and 37% subjects were using antiglare screen.

After 3 months of VDU use 10% subjects developed asthenopic symptoms and after 6 months of VDU use 42% had asthenopia. Dain SJ *et al*. Gunnarsson *et al.* Gobba FM *et al.* Rossignol MA *et al.* have found a hire prevalence of symptoms of uncomfortable eyes among visual display terminal operator compared with office worker doing comparative job not involving VDTs [2-5].

Therefore VDT work recognized as a high risk factor for eye discomfort or asthenopia. Mean refractive modification with myopia (change down) in emmetropic subjects was -0.037±0.17D. Mean refractive modification with hypermetropia (change up) in emmetropic subjects was +0.0062±0.17D. Refractive modification of emmetropic subjects was not statistically significant ($p>0.05$). Mean Refractive modification in myopic and hypermetropic subjects was not statistically significant ($p>0.05$).

The change in NPC was significant ($p<0.0001$). The change in adduction range and NPA was significant ($p<0.001$). According to Tsubot K, Nakamori K reduced blinking rate, widening of the ocular surface due to raised viewing angle and reduction of stability of pre corneal tear film caused the symptoms of asthenopia among VDT workers [29].

Iwaski *et al.* reported the lacrimation and tear film break up time decreased at approximately 2 hours of VDT works and assumed that change in frequency of blink may be one of the factors including the reduction of the amount of lacrimation but our study not comparable to this study [30].

Amalia *et al.* reported that symptoms that were significantly associated with asthenopia were visual fatigue, heaviness in the eye, blurred vision and headache at the temples or the back of the head. Refractive asthenopia was found in 95.7% of all asthenopia patients with accommodative insufficiency, constituting the most frequent cause at 50.7% [31].

Bhanderi *et al.* reported that 46.3% subjects suffered from asthenopia during or after work on computer. Marginally higher proportion of asthenopia was noted in females compared to males. Occurrence of asthenopia was significantly associated with age of starting use of computer, presence of refractive error, viewing distance, level of top of the computer screen with respect to eyes, use of anti-glare screen and adjustment of contrast and brightness of monitor screen [32].

Shrestha *et al.* reported that accommodative infacility and tired eye were the most common abnormalities and symptom reported. Schirmer's test II was slightly correlated with some ocular, visual and systemic symptoms [33].

Agarwal *et al.* reported that eye strain is the most common ocular complaints among computer users working for more than 6 hours a day and also found that maintaining ideal distance from screen, keeping level of eyes above the top of screen, taking frequent breaks, using LCD monitors and using anti-glare screen and adjusting brightness levels according to workplace reduced these ocular complaints to a significant level [34].

SUMMARY AND CONCLUSIONS

In this study, 100 subjects working at computer centre were included at the start of academic session. Only those were included in the study who had either never worked on computer in past or had been working occasionally. Subsequently only those cases formed a part of study who had to work on computers daily for 4 hours or more.

All subjects were called to Department of Ophthalmology, Pt. B. D. Sharma Post graduate Institute of Medical Science, Rohtak. During each visit they were asked to answer questionnaire about working condition. After recording the symptoms, complete ophthalmological examination was done. Follow up of all cases was carried out after 3 months and 6 months of VDU use. These cases were enquired about asthenopic symptoms. Complete ophthalmological examination was done during each visit. The parameters taken into account.

- Age and sex of subjects.
- Working condition.
- Asthenopic symptoms.
- Modification of refractive status at various months of VDU use.
- Maddox rod test (for phoria).

- Near point of convergence, near point of accommodation and adduction at various intervals.
- Tear film break up time (BUT) and Schirmer's test were done in each case at 0 month, 3 months and 6 months of VDU use.

The following conclusions were drawn from present study

A. In the present study all subjects were in the age group of 15 to 25 years. Mean age was 19.7±0.179 years. The number of male and female subjects was 71 and 29 respectively with sex ratio 2.4:1.

B. Most of subjects (91%) were working in bright illumination at computer centres which were equipped with VDT with colour monitor. Only 65% subjects had air cooling system at their work place. 37% subjects were using anti-glare screen. 57 subjects were using VDT in straight gaze while 32 subjects were using VDT in down gaze. Remaining 11 subjects were using VDT in up gaze.

C. among 100 subjects, 10% subjects had asthenopic symptoms after 3 months of VDT use. After 6 months of VDT use 42% subjects had asthenopia while 58% subjects had no symptoms.

D. After 3 months of VDU use there was no change in refractive status of emmetropic, myopic and hypermetropic subjects. After 6 months of VDU use out of 16 myopic subjects only 3 showed increase in myopia. Their mean refractive modification was -0.2188±0.35D.

Out of 4 hypermetropic subjects only one had increase in hypermetropia after 6 months of VDU use with mean refractive modification +0.18±0.37D.

Out of 80 emmetropic subjects, 4 had myopia (change up) after 6 months VDU use. Their refractive modification was -0.37±0.17D. Only one emmetropic subject had hypermetropia after 6months of VDU use. Mean of this refractive modification was +0.00625±0.55D.

Refractive modification of all groups was not statistically significant. The results were comparable with study done by Rechichi C and Scullica L which showed no significant difference in refractive status of emmetropic, hypermetropic or myopic subjects [35].

E. Convergence insufficiency was diagnosed on the basis of NPC beyond 9.5 cm and poor fusional amplitude on synoptophore (less than 30 degree).

Among 100 subjects with normal NPC at 0 month, 25 had NPC>9.5 cm after 3 months with mean NPC 7.89±1.36 cm. After 6months another 9 subjects had NPC>9.5 cm. Mean NPC at 6 months was 8.11±1.40cm. This change in NPC was significant (p value<0.0001).

40 subjects had adduction less than 30 degree on synoptophore after 3 months of VDU use. At this time mean adduction was 27.55±5.73. From remaining 60 subjects, 25 subjects showed decrease in adduction after 6 months with mean adduction 25.08±5.96. The change in adduction range was significant (p value<.001).

13% subjects had change in NPA after 3 months with mean NPA 8.71±0.4 cm while after 6 months of VDU use 36%had change in NPA. At this time mean NPA was 8.94±0.74 cm. This change in NPA was significant (p value<0.001).These findings are in agreement with the study conducted by Gur S, Ron S, Heicklen-klein A [36].

F. after 3 months of VDU use only 3 subjects showed exophoria while after 6 months of VDU use 9 more subjects showed exophoria. None of subject had esophoria after 6 months of VDU use. Lie I and Wattan RG have also reported similar results.

G. After 3 months of VDU use only 3 subjects had dry eyes (BUT less than 10 seconds and Schirmer's test<10 mm) while after 6 months 11 more subjects had BUT<10 sec and Schirmer's test<10 mm. After 6 months of VDU use out of 42 subjects with asthenopic symptoms only 5 had dry eye sensation and foreign body sensation in eyes with BUT <10 sec and Schirmer's test <10 mm indicating dry eyes. While another 7 subjects had dry eyes with symptoms of ocular fatigue. From remaining 58 subjects without asthenopic symptoms only 2 subjects had dry eyes. But the results were not conclusive.

As we know most people have contacts with computer either at work or at home. Computers and VDUs have become indispensable to many workers. In our study, it was found that more than 50% of VDU workers complain of eye discomfort. Therefore VDT work is recognized as a high risk factor or asthenopia. The limitations of our study were short duration and less number of subjects. An extensive study on VDU workers with large number of subjects and for longer duration is needed to reach any conclusion.

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